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PHILIPPINE TURTLES

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SEVEN PLATES

INTRODUCTION

As compared with Borneo, Java, Sumatra, or Japan, the Philippine Islands are not rich in either genera or species of terrestrial turtles. In fact only three genera, represented by four species, are positively known; these are *Cyclemys, Heosemys,* and *Pelochelys.* Several species representative of other genera have been reported, but there appears to be no specimen to substantiate any of the records. Borneo has representatives of nine genera and about fifteen species; Java, seven genera and nine species; Sumatra, ten genera and thirteen species; Japan and Formosa, six genera and seven species. On the other hand only two genera and two species are known from Celebes.

One new species, *Heosemys leytensis,* from the southern part of Leyte, is described in this paper. Two specimens were collected there by Gregorio Lopez, together with other turtles to be used for dissecting in the zoölogical department of the University of the Philippines. He obtained forty specimens belonging to three species; namely, *Cyclemys dhor, C. amboinensis,* and *Heosemys leytensis.* It would appear that these land turtles are plentiful in that locality. In most localities they are rare; in collecting during seven years I have found less than a half dozen specimens, all of which belonged to *Cyclemys amboinensis.*

According to Manobo accounts a large turtle with a hard shell occurs in Agusan River. Rewards offered for specimens failed to bring forth this turtle; nevertheless, it is extremely

probable that some species of aquatic turtle is present in Agusan River.

The small land turtles already mentioned are seemingly of small economic value. They feed on insects, fruit, what flesh they can find, and sometimes on plants. I do not know that these turtles are ever eaten by man.

The soft-shelled turtle, which occurs in Luzon and very probably in other large islands, is very rare. This is eaten when found, but the number taken is probably so small that its economic food value is scarcely worthy of mention. Individuals of this species are said to attain nearly a meter in length.

Four species of marine turtles are known from Philippine seas. All of these are widely distributed in the Pacific Ocean, the Indian Ocean, and the tropical waters bordering these. The identity of these turtles is in doubt. Boulenger [1] has lumped many of the names, not differentiating between Pacific and Atlantic species. Stejneger and Garman on the other hand recognize the Pacific species as distinct from those in the Atlantic. My treatment of this group is of a preliminary and superficial nature. An examination of numerous carapaces of the green turtle shows three different forms and colors of the shells; but without head, legs, and plastron it is futile to generalize or to attempt a separation of the varieties.

HISTORICAL

One of the earlier writers on the Philippines says:

> There are also very large sea turtles in all the islands. Their shells are utilized by the natives, and sold as an article of commerce to the Chinese and Portuguese, and other nations who go after them and esteem them highly, because of the beautiful things made from them.[2]

Other writers say:

> The fisheries of fine-shelled turtles are also abundant, and they also form a conspicuous product. Some of the shells have markings as deep red as a fine garnet; and the four principal shells are of an extraordinary size.[3]
>
> In this land are very many turtles, of great size; they are larger than a shield. Here is a marvellous thing: when the male and the female have intercourse, they remain thus joined together for twenty or twenty-

[1] Cat. Chel. Rhyn. Croc. Brit. Mus. (1889).

[2] Morga's Sucesos (1609). From Blair and Robertson, The Philippine Islands. The Arthur H. Clark Company, Cleveland, Ohio 16 (1904) 103.

[3] Early Recollect Missions (1624). Translated by Blair and Robertson, op. cit. 21 (1905) 308.

five days. They become so stupefied during this act that the Indians dive into the sea, and tie the feet of the turtles without their perceiving it, and draw these creatures ashore. I have even done this myself.[4]

He went in quest of the father, and carried him as a gift a turtle, the shell of which required two men to lift it—so monstrous in size are the turtles in those seas; some of them I have seen and eaten.[5]

Eschscholtz appears to have been the first writer actually to identify a Philippine turtle. He published in his Atlas in 1835 a drawing of a turtle from Manila Bay under the name *Chelonia olivacea*. Only a few other writers have recorded species of turtles from the Philippine Islands.

BIBLIOGRAPHY

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Lists *Cuora amboinensis* Daudin [= *Cyclemys amboinensis* (Daudin)], *Chitra Indica cumingi* Gray (= *Pelochelys cantorii*), and three marine turtles belonging to the Cheloniidæ.

BOETTGER, OSKAR. Ber. Senck. Nat. Ges. (1890) 34.
Lists *Pelochelys cantorii* from the Philippines.

BOETTGER, OSKAR. Ber. Senck. Nat. Ges. (1890) 43.
Lists *Cyclemys amboinensis* from the Philippines.

BOETTGER, OSKAR. Herpetologische Kenntniss der Calamianen Philippinische Inseln. Abh. Ber. König. Zool. Anthr. Eth. Mus. Dresden 7 (1894–95) 1–6.
Lists *Cyclemys amboinensis* Daudin from Mindoro.

BOULENGER, GEORGE ALBERT. On the herpetological fauna of Palawan and Balabac. Ann. & Mag. Nat. Hist. VI 14 (1884) 81–90.
Lists *Cyclemys dhor* Gray from Palawan and Balabac.

BOULENGER, GEORGE ALBERT. Catalogue of the Chelonians, Rhynchocephalians, and Crocodiles in the British Museum (1889) 1–311, pls. 1–6.
Lists a few Philippine specimens.

CASTO DE ELERA. Catálogo sistemático de toda la Fauna de Filipinas conocida hasta el presente, etc. Manila. Vertebrados 1 (1895) 399–407.
Lists *Dermochelys coriacea* Linnæus, *Platysternum megacephalum*, *Callagur picta* Gray, *Ocadia sinensis* Gray, *Damonia reevesii* Gray, *Bellia crassicola* Gray, *Nicoria spengleri* Gray, *Cyclemys trifasciata* Gray, *C. amboinensis* Daudin, *C. flavomarginata* Gray, *C. platynota* Gray, *Chelone mydas* Linnæus, *C. imbricata* Strauch, *Thalassochelys caretta* Linnæus, *Trionyx subplanus* Geoffroy, *T. sinensis* Wiegmann, *Pelochelys cantorii* Gray, and *Chitra indica* Gray. Some of these species, certainly *Cyclemys amboinensis*, *Pelochelys cantorii*, and the four sea turtles, occur in the Islands; but I do not know of authentic preserved specimens of the other species here listed.

[4] Relation of the Filipinas Islands, Miguel de Loarca. Translated by Blair and Robertson, op. cit. 5 (1903) 167.

[5] Chirino's Relation. Translated by Blair and Robertson, op. cit. 13 (1904) 211.

DE ROOIJ, NELLIE. Reptiles of the Indo-Australian Archipelago 1 (1915) 283–332 (turtles).

Most of the species listed by Casto de Elera are also attributed to the Philippine Islands by de Rooij.

GRAY, JOHN EDWARD. Catalogue of the Tortoises, Crocodiles and Amphisbænians in the collection of the British Museum London (1844).

The following species are attributed to the Philippines: *Caouana olivacea* (= *Chelonia olivacea* Eschscholtz), *Chitra indica* Gray (= *Pelochelys cantorii*), *Testudo stellatus* var. (= *Testudo elegans* Gray), *Cistudo amboinensis* Gray (= *Cyclemys amboinensis* (Gray). *Testudo stellatus* is a doubtful record. Boulenger does not recognize it.[6]

GÜNTHER, ALBERT. List of mammals, reptiles and batrachians sent by Mr. Everett from the Philippine Islands. Proc. Zool. Soc. London (1879) 74–79.

Records *Cuora amboinensis* (= *Cyclemys amboinensis* Daudin) from Dinagat.

SIEBENROCK, F. Synopsis der rezenten Schildkröten. Zool. Jahrb. Suppl. 10 (1909) 427–618.

Attributes a number of species to the Philippine Islands, probably on the strength of Casto de Elera's records.

ECONOMIC IMPORTANCE OF TURTLES

The sea turtles are of distinct economic importance to the Philippines, the export of the shell amounting to several thousand pesos annually. During the fiscal year 1909 the export of tortoise shell reached 2,040 kilograms valued at 34,942 pesos.

The tortoise shell of commerce consists of the hard, bony plates taken from the carapace of the hawksbill turtle, *Eremochelys imbricata* Linnæus. The two largest costals are the most valuable, as they are thicker and heavier than the other shields.

Practically all the Philippine tortoise-shell is brought into the market by native fishermen. Now, while a small number of these turtles is captured by fair means, with hook, net, spear, or trap, by far the greater number is taken when they come ashore to deposit their eggs. The fishermen are so eager to secure their prizes that as a rule they do not give the poor turtle a chance to deposit her eggs before they kill her. This short-sighted policy eventually will result in the destruction of the fisheries unless the turtles are protected during the breeding season, which is from May to August. The turtle fishermen go to small, uninhabited islands, frequently many miles from the large islands surrounding the Sulu Sea, and wait perhaps days for the turtles to come ashore to deposit their eggs.

[6] There is a carapace in the Santo Tomás collection belonging to a species of *Testudo*, and there is a living specimen in the Mehan Gardens in Manila. Very probably these are not Philippine specimens.

If the men are in no especial hurry they may wait until the turtle has deposited her eggs, which sometimes are 150 to 200 in number, and about the size of hens' eggs, with tough leathery shells. The fishermen then kill her before she can reach the water, and dig up the eggs which they use as food. The islands of Bancoran, Lumbucan, Arena, Cavilli, and others in the Sulu Sea, are well-known nesting places of the turtle, and it is only necessary to visit these islands to see the destruction wrought during the nesting period.

The best method of removing the tortoise-shell from the back of the turtle is to immerse the back in boiling water until the shell loosens; another method is to bury the body in the sand for eight days, when the shell becomes loosened; still another is to hold the shell over a slow fire until loosened. This latter process usually is employed. In some countries the live animal is held over the fire until the shell is loosened; it is then turned loose "to grow another shell." This method is barbarous, not only for its cruelty but also for its lack of utility, for the animal promptly dies.

The methods employed in the working of tortoise-shell are quite similar to those used in working horn. As a matter of fact, horn frequently is used as an imitation of tortoise-shell. Slow heat or steam is employed, the shell becoming plastic by immersion in water of 90°C. for two minutes. When cool, it retains any shape given it while hot.[7]

The shell taken from the other marine turtles, *Chelonia japonica* and *Caretta olivacea*, is of little value. It is thin and its only value lies in using it for veneering and inlaying. The flesh of these two species, however, is much more frequently eaten than is that of the hawksbill. There are occasional cases recorded where persons have been poisoned by eating the flesh of these turtles. Sir J. E. Tennent[8] reports a case of poisoning from a specimen of *Chelonia virgata*.

At certain seasons the flesh of the turtle on the southwestern coast of Ceylon is avoided as poisonous, and some lamentable instances are recorded of deaths ascribed to its use. At Pantura, to the south of Colombo, twenty-eight persons who had partaken of turtle in October, 1840, were immediately seized with sickness, after which coma supervened, and eighteen died during the night. Those who survived said there was nothing unusual in the appearance of the flesh except that it was fatter than ordinary.

In November, 1917, there occurred in the Philippines a case of poisoning, from eating the flesh of a large turtle. Fourteen deaths resulting were reported out of thirty-three cases of poisoning. The following is the official communication. It was suspected that the flesh had been poisoned by some one, but an

[7] Seale, A., Philip. Journ. Sci. § D 6 (1911) 293.

[8] The Natural History of Ceylon. London, Longman, Green Longman, and Roberts (1861) 292.

examination of the flesh failed to reveal the presence of any poison.

BANTAYAN, *November 28, 1917.*

Dr. AUGUSTO P. VILLALON,
Oficial Sanitario del Distrito,
Cebú, Cebú.

SEÑOR: Bajo cubierta por separado tengo el honor de remitir a V. un ejemplar de la carne de tortuga, que, según anterior comunicación ha producido 33 envenenamientos, con 14 defunciones. Hemos considerado 33 envenenamientos porque éstos 33 son los únicos, que han tenido síntomas de tal.

Pero ahora estamos descubriendo otros, que sienten los síntomas después de 8 días. Felipa Espina y Cesario Espina han estado sin síntomas del envenenamiento por espacio de 8 días después de la ingestión de dicha carne, pero últimamente han tenido manifestaciones análogas a las de los fallecidos y fallecieron también después de 3 y 6 días respectivamente con gran tendencia al sueño y marcada debilidad.

Otro niño de dos años está en estado grave, pero hay esperanzas de curación.

Refiriéndome a los síntomas observados, consisten en mareos y vomitos persistentes, dolores en la garganta y los labios y somnolencia irresistible parecido al envenenamiento por la morfina. Pero lo más notable es la recidiva después de un tiempo bastante dilatado de curación. También es de notar la repentina tendencia al sueño desde el momento, que se observan las manifestaciones y aunque, al parecer, mejoran bajo los tratamientos empleados, sin embargo, vuelvan otra vez a agravarse hasta que por fin fallecen.

Someto a su consideración las anteriores observaciones y puedo someterle más informes, si fuese necesario.

Muy respetuosamente,

[Fdo.] SEGUNDO ISAAC,
Médico de Distrito Interino,
Sección Sanitaria No. 6.

Whether or not the species is poisonous only at this season (the case reported by Tennent occurred in October) or whether the animal becomes diseased is impossible to say.

Little is known regarding the large leatherback *Dermochelys schlegelii.* It is a very rare visitor to the Philippine coasts. I believe the specimen in the Ateneo de Manila is the only authentic Philippine specimen now preserved.

DISTRIBUTION OF TURTLES

The distribution of the genera of turtles occurring in southeastern Asia, Japan, and the Malay Archipelago is shown in Table 1. It is reasonable to expect that representatives of certain genera occurring in adjoining land masses will be eventually

recorded from the Philippine Islands. Three of the species occurring in the Philippine Islands, *Cyclemys dhor, C. amboinensis,* and *Pelochelys cantorii,* are widely distributed in southeastern Asia and the Malay Archipelago. The fourth land species, *Heosemys leytensis,* is known only from Leyte.

TABLE 1.—*Distribution of eastern genera of turtles.*

Genus.	Japan.	Philippines.	Borneo.	Sumatra.	Java.	Malay Peninsula.	Celebes.	New Guinea.	Australia.
Devisia								×	
Ocadia	×								
Clemmys	×								
Callagur			×			×			
Orlitia			×	×					
Batagur				×		×			
Geoclemys	×				×	×			
Bellia			×	×		×			
Geoemyda	×		×	×					
Heosemys	×	×	×	×	×	×			
Cyclemys	×	×	×	×	×	×	×		
Testudo			×	×		×	×		
Chelodina								×	
Emydura								×	×
Carettochelys								×	
Chelonia	×	×	×	×	×	×	×	×	
Caretta	×	×		×	×	×	×	×	
Eretmochelys	×	×	×	×	×	×	×	×	
Dermochelys	×	×	×	×		×			
Dogania			×	×	×	×			
Pelochelys		×	×	×		×		×	
Amyda	×		×	×	×	×			

LOCAL PHILIPPINE NAMES OF TURTLES

Antipa (Tagalog) is *Pelochelys cantorii.*
Bao (Visayan) is *Cyclemys amboinensis* and *C. dhor.*
Bayuyuco (Tagalog) is *Cyclemys amboinensis.*
Cala (Tagalog) is a name applied to marine forms, especially *Eretmochelys imbricata.*
Pagong (Tagalog) is *Cyclemys amboinensis* and *C. dhor.*
Pauican (Tagalog) is a name applied to marine forms.
Pao (Pampanga) is *Cyclemys amboinensis.*
Sisican (Visayan) is *Eretmochelys imbricata.*

CLASSIFICATION OF THE TURTLES

Stejneger's [9] system of classification is followed in this paper.

Class REPTILIA

Reptilia LAURENTI, Synops. Rept. (1768) 19.

Subclass SYNAPSIDA

Synapsida OSBORN, Science 17 (1903) 276.

Order TESTUDINATA

Testudinata OPPEL, Ordn. Rept. (1811) 3.

Key to the Philippine suborders of Testudinata.[9]

a^1. No solid carapace, the vertebræ and ribs being separated from a shell consisting of a mosaic of numerous small polygonal bony plates embedded in a leathery skin; no descending process of the parietal bone; limbs without claws ..... **Athecæ.**

a^2. A solid carapace, of a few large symmetrical bony plates, not separated from the underlying vertebræ and ribs; parietals with descending processes; limbs with at least one claw each.

b^1. Body covered with horny scutes arranged differently from the bony plates beneath; epiplastra and hyoplastra in contact, not separated by entoplastron; center of last cervical and first dorsal vertebræ articulating with each other; fourth digit never with more than three phalanges; jaws covered by horny sheaths not concealed under fleshy lips ..... **Laminifera.**

b^2. Body covered by an undivided leathery skin without scutes; epiplastra separated by entoplastron from hyoplastra; last cervical vertebra articulating with first dorsal by zygapophyses only; fourth digit with more than three phalanges; jaws concealed under fleshy lips. **Chilotæ.**

Key to the Philippine families of turtles.[10]

a^1. Limbs clawless; skin with very numerous polygonal plates; back with five longitudinal keels or ridges (Athecæ) ..... **Dermochelidæ.**

a^2. Limbs with at least one claw each; skin with or without large regular plates; back, if keeled, with at most only three longitudinal keels.

b^1. Outer body covering a soft skin without horny plates (Chilotæ). **Trionychidæ.**

b^2. Outer body covering consisting of symmetrical horny plates (Laminifera).

[9] Bull. U. S. Nat. Mus. 58 (1907) 483 and 484.

[10] A species belonging to the Platysternidæ has been incorrectly reported from the Philippines by Casto de Elera and by Siebenrock.

c^1. Limbs not paddle-shaped; four or five claws on each leg. **Testudinidæ.**

c^2. Limbs paddle-shaped; one or two claws on each leg..... **Cheloniidæ.**

Suborder ATHECÆ

Athecæ COPE, Proc. Am. Assoc. Adv. Sci. 19 (1871) 235.

DERMOCHELIDÆ

Dermochelidæ STEJNEGER, Bull. U. S. Nat. Mus. 58 (1907) 485.

Genus **DERMOCHELYS** Blainville

Dermochelys BLAINVILLE, Jour. de Phys. 83 (1816) 259; Bull. Soc. Philom. (1816) 119; BOULENGER, Cat. Chel. Rhyn. Croc. Brit. Mus. (1889) 7; Fauna India, Rept. (1890) 50; STEJNEGER, Bull. U. S. Nat. Mus. 58 (1907) 485, figs. 373–376.

Sphargis MERREM, Tent. Syst. Amph. (1820) 19; FITZINGER, Neue. Class. Rept. (1826) 5; DUMÉRIL and BIBRON, Erp. Gén. 2 (1835) 559; GRAY, Cat. Tort. (1844) 51; Cat. Shield Rept. 1 (1855) 71; Suppl. Cat. Shield Rept. (1870) 119.

Coriudo FLEMING, Philos. Zool. 2 (1822) 271.

Scytina WAGLER, Isis (1828) 861.

Dermatochelys WAGLER, Nat. Syst. Amph. (1830) 133; STRAUCH, Chel. Stud. (1862) 58; GÜNTHER, Rept. Brit. India (1864) 55.

Chelyra RAFINESQUE, Atlan. Jour. 1 (1832) 64.

Dorsal shield completely bony, exoskeleton consisting of irregular, juxtaposed, mosaiclike plates. Plastral elements eight; no entoplastron; legs paddle-shaped, clawless, digits of foreleg much elongated; phalanges without condyles; beak with two triangular cusps, between three deep notches; no enlarged alveolar surface, jaws simply sharp-edged; head covered with small shields; carapace with seven keels, plastron with five.

It is extremely difficult to determine whether there is more than one species belonging to this genus. Specimens belonging to the genus are found in temperate and tropical parts of the Atlantic and Pacific Oceans and in the Indian Ocean and the Mediterranean Sea. Certain authors maintain that the Atlantic and Pacific forms are identical. Garman has separated the Atlantic and the Pacific forms and has given the name *D. schlegelii* to specimens found in the Pacific and Indian Oceans, and Stejneger follows him in the retention of this name. R. A. Philippi has described a species, *Sphargis angustata*, from Chili.[11]

[11] Ann. de Univers. Mem. Cient. Lit. (1899) 102–104, 730, 2 plates.

Until it can be proved that *D. schlegelii* and *D. coriacea* are identical, I believe that Garman's name should stand for the species occurring in the western Pacific and Indian Oceans.[12]

Dermochelys schlegelii (Garman).

Sphargis mercurialis TEMMINCK and SCHLEGEL, Fauna Japon., Rept. (1835) 6, pl. 1; pl. 2, figs. 3–5; pl. 3; OKADA, Cat. Vert. Japan (1891) 71.

Sphargis coriacea BLEEKER, Natuurk. Tijds. Neder. Indië 15 (1850) 260; TICKEL, Journ. As. Soc. Bengal 4 (1862) 367; McCOY, Nat. Hist. Victoria 2 (1885) 1.

Dermochelys coriacea GÜNTHER, Rept. Brit. India (1864) 55; BOULENGER, Cat. Chel. Rhyn. Croc. Brit. Mus. (1889) 10; Fauna Brit. India, Rept. (1890) 50; BURNE, Proc. Zool. Soc. London 1 (1905) 291.

Sphargis coriacea var. *schlegelii* GARMAN, Bull. U. S. Nat. Mus. 25 (1884) 303.

Sphargis schlegelii GARMAN, Bull. U. S. Nat. Mus. 25 (1884) 295; STEJNEGER, Bull. U. S. Nat. Mus. 58 (1907) 485.

Description of species.—Head covered with small horny plates, usually with a transverse row across snout posterior to nostrils; a rather large parietal plate and a row of elongate scales in supra-ocular region; scales on occipital and temporal regions small, irregular; carapace covered with small, irregular, angular shields of nearly equal size; a small supracaudal extension of carapace; five dorsal keels composed of larger quadrangular shields; two lateral keels; plastron continuous with carapace below, composed of small shields; plastron with five keels, outer keels forming an angle near axilla and continuing to anterior point of plastron; legs large, paddle-shaped; forelegs without claws, in young about as long as carapace, shorter in adult; mouth with a strong beak, with two triangular cusps between three deep notches; jaws sharply edged; alveolar region not enlarged.

Color.—Dark brown above, with or without yellow spots; longitudinal keels yellow in the young, and the legs bordered with yellow.

[12] Garman, Bull. U. S. Nat. Mus. 25 (1884) 294, says: "However, there is only one case in which there is any doubt, that of *Sphargis*, of which specimens from the different oceans are so much alike that writers are still undecided whether there is more than one species. Certain respects in which the Pacific "Trunkbacks" differ from those of the Atlantic have induced me to separate them, distinguishing the former by the name *Sphargis schlegelii*, and the latter by that by which it is commonly known, *Sphargis coriacea*."

Measurements of Dermochelys schlegelii (Garman).[13]

	mm.
Total length	1,500
Length of carapace	1,238
Width of plastron	842
Length of foreleg	763
Length of plastron	1,000
Length of hind leg	422
Transverse diameter of eye	52
Length of head	200
Width of head	176

Remarks.—This huge sea turtle, commonly known as *Sphargis coriacea,* is included here on the strength of a large stuffed specimen in the Ateneo de Manila, which was caught at Malabon, Manila Bay, and has been in the museum for a number of years. It is adult and measures more than 2 meters from head to end of carapace.

Suborder LAMINIFERA

Laminifera HEMPRICH, Grundr. Naturg. (1820) 102.

TESTUDINIDÆ

Testudinidæ GRAY, Ann. Phil. **10** (1825) 210.

EMYDINÆ

Emydinæ, GRAY, Ann. Phil. **10** (1825) 210, part.

Turtles without paddle-shaped legs, and with more than two claws on each digit.

Many genera are associated under this subfamily, and these constitute most of the species of known turtles. They are widely distributed in all temperate and tropical countries. They are terrestrial and aquatic and are both vegetable and animal feeders.

There are only two genera positively known from the Philippines; these are *Cyclemys* and *Heosemys.* Representatives of several other genera are attributed to the Philippine Islands by Casto de Elera,[14] Siebenrock,[15] and de Rooij.[16] Among these are *Callagur, Bellia, Geöemyda, Ocadia,* and *Damonia.* It is not impossible that representatives of some of these genera will be found in the Philippine Islands, but I believe there are no authentic specimens preserved in any collection.

[13] After Schlegel, Fauna Japon. (1835) 9.
[14] Cat. Fauna Filipinas 1 (1895) 400, 401.
[15] Zool. Jahrb. Suppl. 10 (1909) 450–508.
[16] Rept. Indo-Aust. Arch. 1 (1915) 288–307.

Key to the Philippine genera of the Emydinæ.

a^1. A temporal arch; plastron not attached solidly to carapace. **Cyclemys.**

a^2. No temporal arch; plastron attached solidly to carapace..... **Heosemys.**

Genus **CYCLEMYS** Bell

Terrapene MERREM, Tent. Syst. (1820) 27; BELL, Zool. Journ. (1825) 308, part; FITZINGER, Neue Class. Rept. (1826) 6; STRAUCH, Chel. Stud. (1862) 25.

Kinosternon BELL, Zool. Journ. 2 (1825) 302, part.

Sternothærus BELL, Zool. Journ. 2 (1825) 305, part.

Emys WAGLER, Nat. Syst. Amph. (1830) 138, part; STRAUCH, Chel. Stud. (1862) 27; Mém. Acad. Sci. St.-Pétersburg **38** (1890) 14.

Sternothærus WAGLER, Nat. Syst. Amph. (1830) 137.

Cistudo GRAY, Syst. Rept. (1831) 17, part; DUMÉRIL and BIBRON, Erp. Gén. 2 (1834) 207; GRAY, Cat. Tort. (1844) 29.

Cyclemys BELL, Proc. Zool. Soc. London (1834) 17; GRAY, Cat. Shield Rept. 1 (1855) 42; GÜNTHER, Rept. Brit. India (1864) 15; GRAY, Suppl. Cat. Shield Rept. 1 (1870) 22; BOULENGER, Cat. Chel. Rhyn. Croc. Brit. Mus. (1889) 128; Fauna India, Rept. (1890) 28; STEJNEGER, Bull. U. S. Nat. Mus. **58** (1907) 503; SIEBENROCK, Sitzb. Ak. Wiss. Wien 112 (1903) 340; Zool. Jahrb. Suppl. 10 (1909) 500; MOCQUARD, Rev. Colon. Rept. Indo-Chine 10 (1907); DE ROOIJ, Rept. Indo-Aust. Arch. 1 (1915) 301.

Cuora GRAY, Cat. Shield Rept. 1 (1855) 22; GÜNTHER, Rept. Brit. India (1864) 11; GRAY, Suppl. Cat. Shield Rept. 1 (1870) 21.

Pyxidea GRAY, Proc. Zool. Soc. London (1863) 175; GÜNTHER, Rept. Brit. India (1864) 16; GRAY, Suppl. Cat. Shield Rept. (1870) 20.

Pyxiclemys GRAY, Proc. Zool. Soc. London (1863) 176.

Cystoclemmys GRAY, Suppl. Cat. Shield Rept. (1870) 20.

Notochelys GRAY, Suppl. Cat. Shield Rept. (1820) 21; GÜNTHER, Rept. Brit. India (1864) 17.

Head normal, with smooth leathery skin, undivided into plates or tubercles; choanæ between eyes; skull with a bony temporal arch and a broad postorbital arch; neural plates hexagonal; plastron united to carapace by a ligament, divided into two lobes, movable between hyoplastron and hypoplastron; alveolar surfaces without median ridge; entoplastron intersected by humeropectoral suture; digits webbed or nearly free; four clawed digits on hind foot, five on forefoot; tail short.

The two Philippine species, *Cyclemys amboinensis* and *C. dhor*, are widely distributed from southern and southwestern Asia throughout the Malay Archipelago. Casto de Elera also lists *Cyclemys platynota* Gray, *C. flavomarginatus* Gray, and *C. trifasciata* Gray. I have been unable to verify these records.

Key to the Philippine species of Cyclemys.

a^1. Plastron not completely closing shell; posterior margin of carapace serrated ..... **C. dhor Gray.**

a^2. Plastron nearly completely closing shell in adult; posterior margin of carapace not serrated..... C. amboinensis Daudin.

Cyclemys amboinensis (Daudin). Plate 1, figs. 1 and 2; Plate 2, figs. 3 and 4; Plate 3, figs. 2 and 3.

Testudo amboinensis DAUDIN, Rept. 2 (1802) 309.

Emys amboinensis SCHWEIGGER, Prodr. (1824) 45.

Emys couro SCHWEIGGER, Prodr. (1824) 46; SCHLEGEL, Fauna Japon., Rept. (1833) 63.

Terrapene amboinensis MERREM, Tent. Syst. Amph. (1820); STRAUCH, Chel. Stud. (1862) 99; Verth. Schildkr. (1865) 47; SOWERBY and LEAR, Tort. (1872) pl. 23.

Kinosternum amboinensis BELL, Zool. Journ. (1825) 305.

Terrapene bicolor BELL, Zool. Journ. (1825) 484, pl. 16.

Terrapene couro FITZINGER, Neue Class. Rept. (1826) 45.

Cistudo amboinensis GRAY, Syn. Rept. (1831) 19; Ill. Ind. Zool. 1 (1832) pl. 57, fig. 2; DUMÉRIL and BIBRON, Erp. Gén. 2 (1835) 215, pl. 15, fig. 2 (Manila); GRAY, Cat. Tort. (1844) 30 (from Philippines); GEIBEL, Zeit. f. ges. Natur. 27 (1866) 11.

Cuora amboinensis GRAY, Cat. Shield Rept. 1 (1855) 41; GÜNTHER, Rept. Brit. India (1864) 12, pl. 4, figs. *a*, *b*; GRAY, Suppl. Cat. Shield Rept. 1 (1870) 21; Appendix (1872) 10; THEOBALD, Cat. Rept. Brit. India (1876) 7; GÜNTHER, Proc. Zool. Soc. London (1879) 75 (Dinagat); MÜLLER, I Nachtr. Cat. Herp. Samml. Mus. Basel (1880) 49 (Luzon, Negros); BOETTGER, Ber. Senck. Nat. Ges. (1886) 92.

Cyclemys amboinensis BOULENGER, Cat. Chel. Rhyn. Croc. Brit. Mus. (1889) 133; Fauna India, Rept. (1890) 31, fig. 10; Fascic. Mal. Zool. 1 (1903) 343; FLOWER, Proc. Zool. Soc. London (1896) 859; (1899) 614; WERNER, Zool. Jahrb. Syst. 13 (1900) 482; LAIDLAW, Proc. Zool. Soc. London 2 (1901) 582; BOETTGER, Abh. Senck. Ges. Frankfurt 25 (1901) 364; SIEBENROCK, Sitzb. Akad. Wiss. Wien 112 (1903) 343; Zool. Jahrb. Suppl. 10 (1909) 503; DE ROOIJ, Rept. Indo-Aust. Arch. 1 (1915) 302; BARBOUR, Mem. Mus. Comp. Zool. Harvard Coll. 44 (1912) 143.

Description of species.—(From No. 1460, Bureau of Science collection; collected on Polillo, P. I., October, 1909, by C. Canonizado.) Head moderately large, completely retractile; snout bluntly pointed, nostrils anterior, very close together; eyes diagonally set; upper jaw with only slight hook, finely denticulated; top of head covered with smooth leathery skin, undivided; a very slight elevation on skull just behind eyes; carapace smooth, convex, with a single median keel, dim anteriorly, but distinct posteriorly; five vertebral shields, only third longer than wide, all narrower than costals; latter shields wider than long, four on each side; eleven marginals on each side; a small nuchal, longer than wide; supracaudals small, longer than wide, slightly notched; posterior edge of carapace not or but very slightly serrate; plastron about the size of opening of shell, only slightly pointed

behind with notch in posterior part; gular shields small, longer than wide, without notch, suture between them much longer than that between humerals; transverse suture between humerals and pectorals curved, the curve convex anteriorly; pectorals as broad as long, their mutual suture as long as or a little shorter than mutual suture of abdominals; femorals broader than long, suture between them and abdominals curved, the curve convex posteriorly; anals longer than broad, triangular, their mutual suture as long as that between abdominals; hinge between pectorals and abdominals very flexible; sutures between pectorals and marginals about same as that between abdominals and marginals; foreleg moderately long, with five clawed digits, claws more than half the length of digits; a short web between digits; forearm with numerous broadened scales; two large scutes and two small ones on inner side of arm, four large unequal-sized scutes on underside of foreleg; bottom of foot covered with small equal-sized scales; toes covered with imbricate plates, five above longest toe; hind leg longer than foreleg, with four clawed digits; a few enlarged scutes on posterior side of leg; no large scales on upper or anterior side; a few enlarged scales on heel and numerous unequal-sized scales on foot, larger than those on forefoot; tail short, with a double series of subcaudal plates, twelve or thirteen pairs in all; exposed skin of body covered with fine tubercles.

Color in life.—(From a living specimen in the Bureau of Science aquarium.) Brown above, with very indistinct darker areas on back; below, marginals yellow, each with a large black area on outer posterior edge; plastral scales each with a large irregular black blotch covering about one-third of each scute; head uniform dark brown above; a broad brown stripe as wide as head continuing on neck; a yellow stripe from point of snout along canthus rostralis through upper part of orbit and across temporal region where it widens slightly; a dark brown line begins below the yellow one on point of snout, runs through eye, then widens and continues on side of neck to body; a second yellow stripe begins on snout, below the brown line, and passes through eye to ear where it is lost in the yellow of side of neck; below this a brown line crosses lower part of orbit to ear; below this another yellow line with a thin brown line below it; a brown line borders lower jaw and continues to below ear; chin and throat yellow to flesh color; a short black stripe on posterior part of neck on side; legs mottled with gray; forelegs usually with dim light stripes, continuing on toes.

Measurements of Cyclemys amboinensis (Daudin).

	mm.
Total length, head extended	238
Total length of carapace	158
Greatest width of carapace	110
Height of body	70
Length of plastron	150
Width of plastron	78
Length of posterior lobe	84
Length of anterior lobe	65
Length of tail, behind anus	20
Length of head	38
Width of head	24

Variations.—In the Bureau of Science collection there are three other adult specimens from Polillo and five young ones. The adults all agree in the smoothness of the carapace; in two (Nos. 1463 and 1464) the trace of the dorsal keel is almost effaced, and the anal shields are fused into a single large shield. In the specimen described they are only partially fused. In the fourth specimen (No. 1462) the two plates are distinct. This specimen has a broad regular depression along the middle of the plastron, while in the other three the plastrons are gently convex. A specimen (No. 1475) from Laguna Province, Luzon, exhibits a partial fusion of the anal shields and only a dim trace of the dorsal keel. The amount of black on the plastron varies considerably. In certain specimens the black almost covers the entire plastron; in others it is almost wanting.

Young.—The young differ rather markedly from the adults. A very strong, blunt keel from nuchal plate to end of last vertebra; vertebral shields distinctly wider than long, very nearly as wide as costals; two fine distinct keels passing along upper half of costals; marginals very much broader proportionally than in the adult; carapace very finely sculptured; plastron with a distinct, transverse depression across hinge; anal plates distinct, suture of abdominal plate with the marginals larger than that of pectoral with the marginals. Carapace uniform dark brown; dark color on plastron forming a single continuous figure and not reaching outer edge of scutes; dark areas at union of plastron with marginals, and dark spots on underside of marginals.

There are two other adult specimens in the Bureau of Science collection. In a living specimen in the Bureau of Science aquarium the carapace retains the three keels; the shields are roughly sculptured on the upper posterior parts and the concentric growth lines are very distinct, with a few, slight, radiating ridges. The posterior edge of the carapace is distinctly serrate

and there is a distinct notch between the supracaudals; there is a small notch in the plastron between the anals. The very important character of the posterior serrations on the carapace suggests a distinct geographic race. The locality from which the specimens came is unknown.

Remarks.—Turtles of this species are fairly common in the Philippine Islands or at least are frequently seen, because they are often kept as pets. The adults are often found at a considerable distance from water; the young, however, are aquatic. The species is known from Luzon, Polillo, Dinagat, and Mindanao. It ranges from southeastern Asia through the Malay Archipelago to Celebes and Amboina. The name for the species in the Visayan dialects is *bao*.

Cyclemys dhor Gray.[17] Plate 2, figs. 1 and 2; Plate 4.

Emys dhor GRAY, Syn. Rept. (1831) 20, part.

Cyclemys orbiculata BELL, Proc. Zool. Soc. London (1834) 17; Mon. Test. (1842) pls. 24 and 25; GRAY, Proc. Zool. Soc. (1863) 178; THEOBALD, Journ. Linn. Soc. 10 (1870) 12.

Emys dentata GRAY, Ill. Ind. Zool. 2 (1834) pl. 58, fig. 2.

Cistudo diardii DUMÉRIL and BIBRON, Erp. Gén. 2 (1834) 227.

Cistudo dentata GRAY, Cat. Zool. (1844) 32.

Emys diardii SCHLEGEL, Verli. Natuurk. Afbeeld. 44 (1849) figs. 6 and 7.

Cyclemys dentata GRAY, Cat. Shield Rept. 1 (1855) 42, pl. 19; JERDON, Proc. As. Soc. Bengal (1820) 68; THEOBALD, Cat. Rept. Brit. India (1876) 8.

Emys dhor STRAUCH, Chel. Stud. (1862) 28; Verth. Schildkr. (1865) 58.

Cyclemys oldhami GRAY, Proc. Zool. Soc. London (1863) 178; GÜNTHER, Rept. Brit. India (1864) 15, pl. 5, fig. 6; GRAY, Suppl. Cat. Shield Rept. 1 (1870) 23.

Cyclemys ovata GRAY, Proc. Zool. Soc. London (1863) 178; Suppl. Cat. Shield Rept. 1 (1870) 23.

Cyclemys bellii GRAY, Proc. Zool. Soc. London (1863) 179.

Cistudo orbiculata GEIBEL, Zeits. f. ges. Natur. 27 (1866) 13.

Cyclemys dhor GRAY, Suppl. Cat. Shield Rept. 1 (1870) 23; BOULENGER, Cat. Chel. Rhyn. Croc. Brit. Mus. (1889) 131; Fauna India, Rept. (1890) 30; Ann. & Mag. Nat. Hist. VI 14 (1894) 82 (Palawan); BARTLETT, Note Book Sarawak 1 (1894) 3; FLOWER, Proc. Zool. Soc. London (1899) 613; CARRUCCIO, Boll. Soc. Zool. Ital. II 1 (1900) 95; WERNER, Zool. Jahrb. Syst. 13 (1900) 482; BROWN, Proc. Acad. Nat. Sci. Philadelphia 54 (1902) 176; SIEBENROCK, Sitzb. Akad. Wiss. Wien 112 (1903) 341; Zool. Jahrb. Suppl. 10 (1909) 501; MOCQUARD, Rev. Col. Paris (1907) 11; DE ROOIJ, Rept. Indo-Aust. Arch. 1 (1915) 302.

[17] Stejneger is of the opinion that the name *dentata* should be retained rather than *dhor*, see Mem. Mus. Comp. Zool. 44 (1912) 143. Gray, in his later work, chose *dhor* as the name for retention.

Description of species.—(From a living adult specimen,[18] belonging to W. Schultze, Manila, P. I., collected in Palawan.) Head moderately large, completely retractile. Snout slightly peaked just above nostrils, curving in profile from nostrils to mouth; nostrils anterior, very close together; upper jaw with a distinct bicuspid hook; top of head covered with smooth skin, skin in temporal region and on side of head distinctly lined and broken; a slight elevation across skull just behind eyes; head somewhat depressed in occipital region; carapace smooth, distinctly flattened on top, with an obscure keel from nuchal along median line to supracaudals, more prominent posteriorly; a slight broad depression on each side of keel; five vertebral shields, all distinctly broader than long, except first, which is as broad as long, all narrower than the three anterior costals; costals distinctly broader than long, except last, which is longer than broad; eleven marginals on each side; nuchal very small, a little longer than broad; supracaudals moderate, not or scarcely notched behind; carapace somewhat serrated on posterior border, smoothly rounded laterally and with an irregular border anteriorly; plastron about as large as opening of shell, anterior part extending a little beyond anterior edge of carapace, posterior part not extending as far as carapace; a transverse hinge between hyoplastron and hypoplastron, this hinge not corresponding to suture between pectoral and abdominal shields; however, plastron flexible on suture between pectorals and abdominal shields; gular shields triangular, their anterior edges truncate, forming a straight line, their mutual suture much longer than that between humerals; a slight but distinct notch between humerals and gulars on edge of plastron; suture between humerals and pectorals forming a wavy line; suture between pectorals and abdominals curving strongly, convex posteriorly; mutual suture of pectorals longer than that of other shields; suture of pectorals with marginals much shorter than that of abdominals with marginals; suture between abdominals and femorals curved slightly convex posteriorly; suture between anals and femorals strongly curved convex anteriorly; anals with a curved notch, their mutual suture longer than that of femorals; intercalary, axillary, and inguinal shields very small; on anterior part of humerals a trace of a straight suture corresponding to hinge; the two elements formed by the suture are entirely coalesced; anterior part of foreleg covered with irregular enlarged shields; digits five, partly

[18] I am under obligation to Mrs. W. Schultze for the privilege of describing this specimen.

webbed, all covered above with transverse scales, each equipped with a strong curved claw; forefoot with small irregular scutes on sole; on underside of foreleg only a few enlarged scutes; hind leg with four digits, each equipped with strong curved claws; hind leg with no enlarged scales except on heel; tail with eight pairs of enlarged subcaudal scales.

Color in life.—Above, carapace light brown, with a few darker spots and a few dim longitudinal spots along keel; plastron and marginals brownish yellow, with distinct radiating lines on each plastral shield; head brownish yellow, with small dark spots on neck with numerous lines of black and yellow; a prominent yellowish line begins in occipitotemporal region, continuing the length of neck; a second prominent line begins immediately behind eye and continues above ear to body; chin and throat lined with black and yellow; upper part of legs somewhat reddish.

Measurements of Cyclemys dhor Gray.

	mm.
Length of carapace	192
Width of carapace	145
Height of carapace	70
Length of plastron	187
Width of plastron	117
Tail, from anus	40

Variation.—Besides the specimen described I have at hand two preserved specimens;[19] one is medium-sized, the other young.

The medium-sized specimen appears somewhat abnormal or diseased, and it is almost impossible to discern the suture between the shields of the carapace; the keel is obliterated save on the posterior part of the carapace. Head brown, strongly mottled with black, markings on side of head and neck somewhat obscured; each abdominal shield divided completely by a straight suture corresponding to hinge of plastron; elements thus formed not contiguous.

The young specimen has a very strong blunt keel the entire length of the carapace; middle costal shields with a small keel on their posterior parts; all shields rugose; marginals distinctly broader proportionally than in adults; posterior part of carapace very strongly serrate, posterior marginals forming sharp points; a very distinct notch between supracaudals; anterior part of carapace serrate; plastron apparently without hinge; no trace

[19] These specimens are unnumbered and belong to the University of the Philippines. They were loaned by Prof. Artemas Day and Dr. R. P. Cowles.

of suture across abdominal shields; a small axillary and a small inguinal shield; no intercalary scutes evident; humerals and abdominals forming direct sutures with marginals; plastral shields rugose. Carapace above olive or yellowish brown, with no dark markings; below very light brown, with dark brown radiating lines around the edges of each shield of plastron and marginals; head with a slight median keel from tip of snout, surface of occipital region finely sculptured; markings on head and neck similar to those of the adult.

There is a carapace of an adult specimen in the Bureau of Science collection which differs from the shell of the adult specimen described, in having the entire outer part of the carapace almost entirely dark blackish brown, and the upper part of the costals and the vertebrals with radiating dotted lines; the carapace is rugose, showing distinctly the lines of growth; the abdominal shields have a strong trace of a suture on their anterior parts.

TABLE 2.—*List of Philippine specimens of Cyclemys dhor Gray.*

No.	Collection.	Locality.	Collector.	Age.
1	W. Schultze	Palawan	W. Schultze	Adult
2	University of the Philippines	Leyte	G. Lopez	do
3	Do	do	do	Young
4	Bureau of Science	Palawan		Adult

No.	Condition.	Carapace.			Plastron.	
		Length.	Width.	Height.	Length.	Width.
		mm.	*mm.*	*mm.*	*mm.*	*mm.*
1	Living	192	145	70	187	117
2	Preserved	154	115	68	146	93
3	Do	75	70	22	64	48
4	Shell	180	148	73	177	120

Remarks.—Individual variation in this widely distributed species is strongly marked. It varies greatly at different ages. One can scarcely find two specimens that are wholly alike. The species is terrestrial in habit, apparently only the young frequenting water. In the Philippines the species is known from Palawan, Balabac, and Leyte. It probably occurs on other large islands. It was first reported from the Philippine Islands by Boulenger [20] in 1894, on the strength of specimens collected by Everett. The species is known from Java, Borneo, Sumatra,

[20] Ann. & Mag. Nat. Hist. VI 14 (1894) 82.

and Nias, Natuna Islands, Banka, Malay Peninsula, Burma, Siam, Annam, and northern India.

Genus **HEOSEMYS** Stejneger

Geoemyda GRAY, Proc. Zool. Soc. London (1834) 100, part; Cat. Tort. (1844) 14; Cat. Shield Rept. (1855) 16; GÜNTHER, Rept. Brit. India (1864) 18; GRAY, Suppl. Cat. Shield Rept. 1 (1870) 25; ANDERSON, Zool. Res. Yunnan (1879) 716; BOULENGER, Cat. Chel. Rhyn. Croc. Brit. Mus. (1889) 135; Fauna India, Rept. (1890) 23; STRAUCH, Mém. Acad. Sci. St.-Pétersburg 38 (1890) 15; SIEBENROCK, Sitzb. Akad. Wiss. Wien 112 (1903) 340; MOCQUARD, Rev. Colon. (1907) 11; DE ROOIJ, Rept. Indo-Aust. Arch. 1 (1915) 298.

Emys DUMÉRIL and BIBRON, Erp. Gén. 2 (1834) 232, part.

Clemmys STRAUCH, Chel. Stud. (1862) 28, part.

Heosemys STEJNEGER, Proc. Biol. Soc. Washington 15 (1902) 238; SIEBENROCK, Zool. Jahrb. Suppl. 10 (1909) 506.

Neural plates mostly hexagonal, short-sided behind; plastron extensively united to carapace by suture; entoplastron intersected by humeropectoral suture; skull lacking a bony temporal arch; anterior part of head covered with undivided smooth skin, posterior occipital and temporal regions with skin divided into scale-like elements; triturating surface of upper jaw rather narrow, without a median ridge; digits fully or partly webbed; five clawed digits on forefoot, four on hind foot; tail very short.

The generic name *Heosemys* was made by Stejneger to include the three species long known under the generic name *Geoemyda*. The latter name, as shown by Stejneger, must stand for the species associated under the name *Nicoria* Gray.

There are three well-known species belonging to the genus *Heosemys;* namely, *H. spinosa* Gray, widely distributed from Burma to the Malay Peninsula and Archipelago; *H. grandis* Gray, found in Burma, the Malay Peninsula, and French Indo-China; and *H. depressa* Anderson, known from Arrakan. A fourth species, from Leyte, Philippine Islands, is here described.

Key to the species of Heosemys Stejneger.

a^1. Anterior margin of carapace serrated.

b^1. Plastron strongly narrowed in front, with a strong notch between gular and humeral shields; plastron uniform yellow or reddish brown ..... **H. leytensis sp. nov.**

b^2. Plastron moderately narrowed in front, with no notch or only a slight one between gular and humeral shields; plastral shields with radiating lines..... **H. spinosa Gray.**

a^2. Anterior margin of carapace not serrated.

b^1. Carapace arched or tectiform in a transverse section.

H. grandis Gray.

b^2. Carapace depressed, flat on vertebral region.

H. depressa Anderson.

Heosemys leytensis sp. nov. Plate 1, figs. 3 and 4; Plate 3, fig. 1.

Type.—An unnumbered specimen in the zoölogical laboratory, University of the Philippines; collected at Cabalian, southern Leyte, P. I., by Gregorio Lopez.

Description of type.—Adult male. Head large, anterior part covered with smooth undivided skin; skin on posterior part of head and in temporal region divided into scalelike elements; snout bluntly pointed, nostrils anterior, separated by a distance equal to or greater than diameter of a single nostril; eye rather small, slit diagonally, diameter of orbit distinctly less than length of snout; upper jaw with a distinct hook, slightly bicuspid; triturating surface of upper jaw narrow, with an indistinct short ridge or keel near inner edge; choanæ between eyes; ear slightly farther from eye than eye from end of snout; carapace smooth above, rather flattened, with no trace of a keel; vertebral shields all wider than long (fifth anomalous and very irregular and broken, forming an extra costal between it and fourth costal on left side) ; costals four on each side normally, much broader than long, much broader than vertebrals; eleven marginals on each side; nuchal triangular, broadest posteriorly; anterior marginals touching nuchal, extending far anterior to nuchal and about five times as large as nuchal; supracaudal plates not or but slightly notched, partially fused; anterior part of carapace deeply notched and serrate; laterally smooth, rounded; posteriorly moderately serrate; plastron narrower, very much smaller than opening of shell, not as long as carapace and not extending as far anteriorly, narrowed in front; plastron joined to carapace by strong bony suture; no intercalary shields; a small axillary and an inguinal shield; narrowest part of bridge contained in total length of plastron a little more than two and one-half times; gular shields quadrilateral, outer sides parallel for a distance equal to about half the length of shield; a large angular notch between gular shields and another between gulars and humerals; mutual suture of gulars longer than that of humerals, the latter somewhat less than suture between pectorals; abdominal shields large, not as broad as pectorals, their mutual suture longer than pectoral or femoral; a deep, more or less semicircular notch between anal shields, suture between anals abnormal; foreleg with transversely somewhat enlarged irregular scales; four prominent scales on upper edge of arm, the two median much the largest; a large transverse scale on heel of forefoot and a few small scales on back part of scale; five digits, each with a strong curved claw, digits fully webbed, foot cushionlike; one or two small scales at

base of claws; four digits on hind foot with strong curved claws; enlarged scutes on upper edge of hind leg and a few small ones on heel, none on sole; two or three enlarged scutes above digits near ends; tail very short, without enlarged scales above or below; skin on legs, body, and neck with minute tubercles, giving it a feel like sandpaper.

Color in alcohol.—Above reddish rusty brown, darker on anterior marginals; uniform reddish brown on plastron, darkest on bridge and on anterior part; head uniform dark brown, slightly lighter posteriorly; a narrow transverse yellow line crossing posterior part of head and continuing to posterior border of ear; upper part of neck dark; lighter, more or less reddish brown on sides and underside of neck; legs dark above, lighter below.

Measurements of Heosemys leytensis sp. nov.

	mm.
Total length, tip of snout to end of tail	330
Length of carapace	210
Width of carapace	145
Height of carapace	70
Length of plastron	180
Width of plastron	115
Length of head	55
Width of head	42
Depth of head	31
Eye to ear	15
Eye to tip of snout	13

Variation.—A second specimen from the same locality is medium-sized and differs in a number of characters from the adult. A dim keel in posterior part of carapace; distinct diagonal grooves in upper part of costal shields, parallel to their sutures with vertebrals; all shields of carapace showing lines of growth; carapace dimly serrate anteriorly, nuchal notch rather shallow; marginals bordering nuchal not extending anterior to nuchal more than half its length (in the adult they extend beyond the nuchal a distance about equal to its length); a distinct notch between supracaudals; plastron similar to that of adult; carapace brown; plastron yellow; top of head brown, dimly mottled in temporal region; two very distinct transverse yellow lines on sides of head which barely fail to meet dorsally, these lines continuing below ear; a yellow spot on each side of lower jaw. Length of carapace, 126 millimeters; of plastron, 118.

Remarks.—Only these two specimens are known. Both are from the same locality in Leyte. The species can be readily

distinguished by the absence of the temporal arch and by the yellow ring on the posterior part of the head.

CHELONIIDÆ

Cheloniidæ COPE, Proc. A. Philos. Soc. 20 (1882) 143.

Large turtles with paddle-shaped legs; nine plastral bones covered with epidermal horny shields; caudal vertebræ procœlous; neck not completely retractile; temple roofed over, parietal bone in contact with squamosal; one or two claws on each leg.

Genus **ERETMOCHELYS** Fitzinger

Caretta RITGEN, Nova Acta Acad. Leop.-Carol. 14 (1828) 270 (not of Rafinesque).
Eretmochelys FITZINGER, Syst. Rept. (1843) 30.
Onychochelys GRAY, Proc. Zool. Soc. London (1873) 397.

Marine turtles, having paddle-shaped legs, each with two claws; carapace with four pairs of costals and two pairs of prefrontal scales; scales of carapace imbricating, with three keels; two keels on plastron.

The turtles of this genus furnish the precious tortoise-shell of commerce, which is an important article of export from the Philippine Islands.

Eretmochelys imbricata (Pennant). Plate 5, figs. 1 and 2; Plate 6, figs. 5 and 6.

Testudo imbricata PENNANT, Ind. Zool. (1769) 87.
Chelonia Eretmochelys imbricata FITZINGER, Syst. Rept. (1843) 30.
Eretmochelys imbricata AGASSIZ, Contr. 1 (1857) 381; STEJNEGER, Report U. S. Nat. Mus. for 1902 (1904) 719.
Chelonia imbricata SCHWEIGGER, Prodr. Mon. Chel. (1814) 21.
Caretta imbricata MERREM, Syst. Amph. (1820) 19.
Onychochelys kraussii GRAY, Proc. Zool. Soc. London (1873) 398.
Chelonia virgata WAGLER, Icon. et Desc. Amph. (1833) pl. 29.
Chelonia multiscutata KUHL, Beitr. (1820) 78.
Chelone imbricata BOETTGER, Ber. Senck. Nat. Ges. (1886) 93 (Jolo).
Eretmochelys squamata AGASSIZ, Contr. Nat. Hist. U. S. Am. 1 (1857) 382; GARMAN, Bull. Mus. Comp. Zool. Harvard Coll. 25 (1883) 300.
Caretta imbricata KELAART, Rept. Ceylon 1 (1852) 180.
Caretta squamosa GIRARD, U. S. Expl. Exp., Rept. (1858) 442.
Caretta rostrata GIRARD, U. S. Expl. Exp., Rept. (1858) 446.
Eretmochelys squamosa STEJNEGER, Bull. U. S. Nat. Mus. 58 (1907) 511.

Description of species.—(From No. 1474, Bureau of Science collection; collected at Aparri, Luzon, November, 1908.) Snout beaked, somewhat projecting over lower jaw; nostrils small, vertical; postnasal shields moderate, five-sided, entering orbit;

prefrontals much larger than postnasals, pentagonal, forming a straight median suture; azygous prefrontal hexagonal; frontal large, eight-sided, with a small suture entering anteriorly, forming its longest sutures with supra-ocular, wider than long; two equal-sized parietals, distinctly shorter than frontal; a large temporal scale bordering frontal; supra-ocular and parietal on each side; three postocular shields entering orbit, two lower largest; these bordered by temporals; two upper temporal elements larger than lower; a large elongate shield on either side of lower jaw; region above eye with small irregular scales; lower lid with tubercular scutes; carapace covered with large imbricating shields; five vertebral shields; four pairs of costal shields; eleven marginal shields on each side; a single nuchal shield; a pair of supracaudal shields; vertebrals with a strong vertebral keel; two lateral keels on upper part of costal; posterior edge of each shield with a thornlike point; posterior edge of carapace strongly serrate; plastral elements normal; a single azygous scute between gulars; pectoral and abdominal shields largest; plastron separated from carapace by a series of four enlarged intercalary shields; a few small axillary shields, largest between humeral and first intercalary; a single small inguinal scale; plastron with two strong keels with a prominent depression between them; legs paddlelike, anterior much larger than posterior; inner side of leg with eight shields, broader than long; tip of leg with two enlarged shields, separated by a smaller shield; outer side of leg with sixteen scutes, two of which bear distinct claws; hind legs with eleven scutes on anterior edge, two of which bear small claws; tail very short, not extending to tip of carapace.

Color in alcohol.—Above deep brown, streaked or mottled with amber of varying shades; legs similar; head shields blackish brown, lighter on sutures; lateral shields amber, with brown spots; plastron yellow to amber, with a brown spot on posterior part of each shield.

Measurements of Eretmochelys imbricata (Linnæus).

	mm.
Total length	244
Length of carapace	173
Width of carapace	130
Length of plastron	134
Width of plastron, across pectorals	81
Length of foreleg	98
Length of hind leg	53
Length of head	47
Width of head	30

Variation.—A very young specimen, measuring 105 millimeters to end of carapace, is dark blackish brown to black; tips of marginals and outer edges of legs yellowish; plastron black; body skin blackish; scutes of head, carapace, and plastron identical with those of the described specimen. A carapace in the Bureau of Science collection measures 395 millimeters. There are three specimens living in the Bureau of Science aquarium.

Remarks.—The turtle here described appears to be of the species figured by Stejneger [21] under the name *Eretmochelys imbricata.* Between Stejneger's drawing and the described specimen in the Bureau of Science collection there is no appreciable difference.

Genus CARETTA Rafinesque

Caretta RAFINESQUE, Specchio Sci. Palermo 2 (1814) 66.
Thalassochelys FITZINGER, Ann. Wien Mus. 1 (1835) 121.
Caouana COCTEAU in Sagra's Hist. Fis. Pol. Nat. Cuba, Rept. 4 (1838) 31.

Marine turtles with paddle-shaped legs; two pairs of prefrontals present; five or more pairs of costal shields; shields on back not imbricate.

Caretta olivacea (Eschscholtz). Plate 6, figs. 1 and 2.

Chelonia olivacea ESCHSCHOLTZ, Zool. Atlas 1 (1829) pl. 3 (Manila Bay).
Caouana olivacea GRAY, Cat. Tort. (1844) 53 (Philippines); GÜNTHER, Rept. Brit. India (1864) 52 (seas of Philippines).
Caretta olivacea GARMAN, Bull. Mus. Comp. Zool. Harvard Coll. 52 (1908) 9.
Thalassochelys olivacea BOETTGER, Ber. Senck. Nat. Ges. (1886) 93.
Thalassochelys caretta CASTO DE ELERA, Cat. Fauna Filipinas 1 (1895) 404 (Manila Bay).

Description of species.—(From a specimen living in the Bureau of Science aquarium.) Anterior pair of prefrontals distinctly smaller than second pair; a small, rather elongate azygous prefrontal between the two supra-oculars; frontal large, much wider than long, followed by four parietals; a large temporal (or parietal) element follows supra-ocular shield and borders frontal and outer parietal; three postocular shields, upper smallest, middle largest, lower elongate; postoculars bordered by four temporals, second from top largest; a distinct median keel on carapace, more prominent posteriorly; six pairs of costals; nuchal divided; six vertebral shields, fifth very small; thirteen marginals on each side; two supracaudals; plastron normal;

[21] Report U. S. Nat. Mus. for 1902 (1904) 718, figs. 193–197.

four large shields between carapace and plastron; a small inguinal shield and a group of eight axillary shields, four of which touch pectorals and humerals; a small round shield behind anal shields.

Color in life.—Above olive drab to gray, rather lighter about suture; sides and underside of neck whitish; plastron whitish.

Measurements of Caretta olivacea (Eschscholtz).

	mm.
Length of carapace	340
Width of carapace	325
Height of carapace	110
Length of foreleg	260
Width of foreleg	70
Length of hind leg	180
Width of hind leg	70
Length of plastron	275
Width of plastron	280
Length of tail, from anus	15
Length of head, to end of parietals	90
Depth of head	55

Variation.—This species is known to be subject to a great amount of variation. Thus the usual number of costals is five; but in the Manila specimen figured by Eschscholtz there appear to be seven on one side and six on the other, with seven vertebrals; there are thirteen marginals on each side. I am uncertain whether the nuchal is divided. There are several characters about Eschscholtz's figure that differ markedly from my specimen, but these may be due to poor drawing. The squamation of the neck, the position of the nostrils, the shape of the occipital region, and the squamation of the legs—all appear to differ greatly.

Remarks.—This species and an agamid lizard appear to be the first recorded Philippine reptiles. The species is not rare and is taken frequently in Manila Bay.

Genus **CHELONIA** Latreille

Chelonia Brongniart, Bull. Soc. Philom. Paris 2 (1800) 89 (*nomen nudum*); Latreille, Hist. Nat. Rept. 1 (1802) 22; Wagler, Syst. Amph. (1830), 132, part; Gray, Syn. Rept. (1831) 51; Duméril and Bibron, Erp. Gén. 2 (1835) 530; Cat. Zool. (1844) 54; Cat. Shield Rept. 1 (1855) 74; Girard, U. S. Expl. Exped., Herp. (1858) 452; Günther, Rept. Brit. India (1864) 52; Gray, Suppl. Cat. Shield Rept. (1870) 119; Stejneger, Bull. U. S. Nat. Mus. 58 (1907) 509.

Chelone Brongniart, Mem. Sav. Etrang. 1 (1806) 610; Strauch,

Chel. Stud. (1862) 59; BOULENGER, Cat. Chel. Rhyn. Croc. Brit. Mus. (1889) 180.

Chelonias RAFINESQUE, Specchio. Sci. Palermo 2 (1814) 66.

Caretta MERREM, Tent. Syst. Amph. (1820) 19, part; GRAY, Cat. Tort. (1844) 53; Cat. Shield Rept. (1855) 73.

Mydas COCTEAU, in Sagra's Hist. Fis. Pol. Nat. Cuba 4 (1838) 22; GRAY, Suppl. Cat. Shield Rept. (1870) 119.

Chelonia japonica (Thunberg). Plate 7, figs. 1 to 4.

Testudo japonica THUNBERG, Svensk. Vetensk. Acad. Nya Handl. 8 (1787) 178, pl. 7, fig. 1.

Chelonia japonica SCHWEIGGER, Prodr. Mon. Chel. (1814) 21.

Chelonia virgata SCHWEIGGER, Prodr. Mon. Chel. (1814) 21.

Chelonia viridis TEMMINCK and SCHLEGEL, Fauna Japon., Rept. (1835) pl. 4, figs. 4, 5, 6; pl. 6, figs. 1, 2.

Chelonia japonica STEJNEGER, Bull. U. S. Nat. Mus. 58 (1907) 509; GARMAN, Bull. Mus. Comp. Zool. Harvard Coll. 52 (1908) 8.

Description of species.—(From a living specimen in the Bureau of Science aquarium.) Head large; beak somewhat hooked; a single pair of large prefrontals, longer than wide, that on right side partially broken; a small azygous hexagonal prefrontal between supra-oculars, which are larger; four postoculars on left side, five on right side, lowest largest; frontal large, somewhat notched in front, bordered behind by five parietals; frontal and parietals bordered by two temporals; postoculars bordered by four shields, two upper largest; this series of temporals followed by five or six unequal-sized shields and two or three very small ones, making a total of about twenty shields in temporal region behind eye; supra-ocular region with a series of small shields; lower jaw with narrow mental followed by a large elongate shield which is followed by several smaller ones; carapace smooth; five vertebral shields; four pairs of costals; eleven pairs of marginals, first pair in contact with first vertebral on either side of nuchal, which is single; a pair of supracaudals; legs long, with a single claw, anterior edge of front leg with fifteen shields, about ten on posterior edge; a round isolated shield near upper part of underside of leg not bordering outer edge; anterior part of hind leg with eight shields; a single claw present; plastron smooth, attached to carapace by four large intercalary plates; six distinct axillary scales; pectoral shields widest on plastron.

Color in life.—Above rusty reddish brown, each shield streaked with amber, head shields distinctly reddish, each edged with black; shields on side of head dark, with yellow along sutures; shields on legs with black centers; plastron yellow.

Measurements of Chelonia japonica (Thunberg).

	mm.
Total length	735
Length of carapace	555
Width of carapace	470
Height of carapace	180
Length of plastron	448
Width of plastron, across pectoral	290
Length of head	125
Width of head	90
Depth of head	100
Tail, behind anus	28

Variations.—The head shields of this species are subject to more or less variation. In a second specimen living in the aquarium there is a second pair of prefrontals bordering the nasal area but not touching the beak. These shields are small and irregular.

Remarks.—The species is common in the Philippine Islands. Specimens have been kept alive in the aquarium. They are very frequently taken in Manila Bay. They are fed on fish.

Suborder CHILOTÆ

Chilotæ WIEGMANN, Handb. Zool. (1832) 167.

This suborder consists of one family.

TRIONYCHIDÆ

Trionychidæ BELL, Zool. Journ. 3 (1828) 515.

Carapace and plastron without outer scales or shields and not entirely ossified, covered with leathery skin; head completely retractile; no external ear; bony part of jaws concealed under thick lips; three digits with claws; nostrils at end of a flexible proboscis.

Only a single genus of this family is positively known from the Philippine Islands. Species of three other genera have been reported but probably erroneously. They are the following:

Dogania subplana (Geoffroy Saint Hilaire.) Reported by Casto de Elera[22] as *T* [*rionyx*] *subplanus*, from Mindanao and Palawan, with specimens in the Santo Tomás Museum and in turn listed from the Philippines by Siebenrock[23] and de Rooij,[24] on the strength of Casto de Elera's record. No specimen is now in the Santo Tomás Museum.

Chitra indica Gray. This species was first reported from the Philippine Islands by Gray, who later made the specimen the type

[22] Cat. Fauna Filipinas 1 (1895) 407.
[23] Zool. Jahrb. Suppl. 10 (1909) 606.
[24] Rept. Indo-Aust. Arch. 1 (1915) 326.

of *Pelochelys cumingii*, which is now regarded as synonymous with *P. cantorii*. Casto de Elera also reports the species from the Philippines, locality Palawan, with a specimen in the Santo Tomás Museum. This specimen is no longer extant.

Trionyx sinensis Wiegmann. Reported by Casto de Elera from the Batan Islands, and later by Siebenrock on the strength of the former record. The specimen reported as present in the Santo Tomás Museum is no longer extant.

Dogania subplana occurs in Java and Borneo; Stejneger regards its presence in Formosa as doubtful. *Chitra indica* is known only from India. *Trionyx sinensis* occurs in Formosa, and a specimen has been reported from Timor.

Genus **PELOCHELYS** Gray

Chitra Gray, Cat. Shield Rept. 1 (1855) 70, part; Günther, Rept. Brit. India (1864) 50.

Pelochelys Gray, Proc. Zool. Soc. London (1864) 89; (1873) 40; Suppl. Cat. Shield Rept. 1 (1870) 90; Boulenger, Cat. Chel. Rhyn. Croc. Brit. Mus. (1889) 262; Fauna India, Rept. (1890) 15; Strauch, Mém. Acad. Sci. St.-Pétersburg VII 38 (1890) 34; Baur, Ann. & Mag. Nat. Hist. VI 7 (1891) 445; Proc. Am. Phil. Soc. 31 (1893) 221; Ogilby, Proc. Roy. Soc. Queensland 19 (1905) 29; Siebenrock, Zool. Jahrb. Suppl. 10 (1909) 606.

"Outer extremities of the nuchal plate overlying the second dorsal rib; neural plates well developed. Limbs completely exposed. Hyoplastron distinct from hypoplastron; not more than five plastral callosities. Bony choanæ between the orbits; jaws weak; postorbital arch as broad as the diameter of the orbit; pterygoids posterior border free, without ascending process." (*Boulenger.*)

Only one species of the genus is known.

Pelochelys cantorii Gray. Plate 6, figs. 3 and 4.

Chitra indica Gray, Cat. Tort. (1844) 49, part; Cat. Shield Rept. (1855) 49; Günther, Rept. Brit. India (1864) 50, pl. 6, fig. C.

Gymnopus indicus Cantor, Cat. Mal. Rept. (1847) 10.

Pelochelys cantorii Gray, Proc. Zool. Soc. London (1864) 90, figs. 9 and 10; (1869) 215; Theobald, Journ. Linn. Soc. (1868) 10; Cat. Rept. Brit. India (1876) 28; Baur, Proc. Am. Phil. Soc. 31 (1893) 221; Ogilby, Proc. Roy. Soc. Queensland 19 (1905) 29; Siebenrock, Zool. Jahrb. Suppl. 10 (1909) 607.

Pelochelys cumingii Gray, Proc. Zool. Soc. London (1864) 90; Cat. Shield Rept. Suppl. (1870) 91 (type locality Philippines).

Pelochelys bibronii Gray, Proc. Zool. Soc. London (1864) 90; Cat. Shield Rept. Suppl. (1870) 91.

Pelochelys cantoris Boulenger, Cat. Chel. Rhyn. Croc. Brit. Mus. (1889) 263; Fauna India, Rept. (1890) 15; Casto de Elera, Cat. Fauna Filipinas 1 (1895) 406; Flower, Proc. Zool. Soc. London

(1899) 621; WERNER, Zool. Jahrb. 13 (1900) 483; SIEBENROCK, Sitz. Ber. Wiss. Wien 111 (1902) 832, fig. 12; 112 (1903) 350; Zool. Jahrb. Suppl. 10 (1909) 607.

Pelochelys cantori DE ROOIJ, Rept. Indo-Aust. Arch. 1 (1915) 331.

Description of species.—"Costal plates eight pairs, the last well developed and forming a median suture; a single neural between the first pair of costals; plates coarsely pitted and vermiculate. Dorsal skin of young tuberculate. Epiplastra small and widely separated; entoplastron forming a right or an acute angle; plastral callosities largely developed. Head moderate; snout very short and broad; proboscis very short; interorbital space broader than the greatest diameter of the orbit; mandible narrowest at the symphysis, olive above, uniform or spotted with darker; lips and throat of young olive, speckled with whitish; plastron whitish." (*Boulenger.*)

A living specimen in the Bureau of Science aquarium has the following measurements:

Measurements of Pelochelys cantorii Gray.

	mm.
Length of carapace	350
Width of carapace	315
Height of carapace	76
Length of plastron	295
Width of plastron	290
Total length, head extended	630

The following characters are evident in the living aquarium specimen: Carapace moderately flat, composed of a bony inner part surrounded by a wide, soft, cartilaginous rim, the part above the neck bending down strongly, more or less covered with fine sculpturing and rounded tubercles; bony part sculptured and more or less pitted; soft part of carapace posteriorly with lines crisscrossed at nearly right angles; on the sides these lines longitudinal and not crossing; a depressed area running lengthwise of carapace medially; three inner toes of fore and hind legs with long, strong claws, the claw of inner toe largest; the two outer toes not extending beyond the edge of the strong web which extends along the leg; a small callosity at base of inner toes on both feet; a strong scalelike callosity across outer part of foreleg, three callosities in the web on outer side of foreleg; one large, elongate callosity in the web on posterior side of hind leg, a heavy widened scalelike callosity on heel; head very large, much widened in temporal region; proboscis short; lips very thick; eye small, with a dark line in front and behind pupil; tail very short behind anus.

Color in life.—Head above olive, with minute black dots; carapace olive, with a few darker and lighter striations along the median dorsal part; outer edge olive, with small spots of darker and lighter color; plastron flesh color, with a few white dots on anterior part; chin and throat with minute dots of black and white.

Remarks.—The specimen [25] in the aquarium was captured in 1918 at San Miguel, Bulacan Province, Luzon, by Mr. Genesio Páting, and was presented to the aquarium by Mr. George Symmonds, of Manila. The turtle does very well in captivity and takes food regularly. The food given is small dead fish. In the same tank are kept specimens of *Cyprinus carpio* (Chinese carp), and *Megalops cyprinoides* (buan-buan), and these living fish are not molested. When living specimens of *Ophiocephalus striatus* (the mud fish, or *dalag*), were placed in the same aquarium they were frequently killed. In Luzon the species is known as *antipa;* it appears to be rare. Individuals grow to be more than a meter long.

[25] The turtle here mentioned died since this paper was written.

ILLUSTRATIONS

[Photographs by E. Cortes.]

PLATE 1

FIG. 1. *Cyclemys amboinensis* (Daudin); a medium-sized specimen, showing serrations on posterior part of carapace.
2. *Cyclemys amboinensis* (Daudin); an old specimen, without serrations and with differently shaped carapace.
3. *Heosemys leytensis* sp. nov.; from the type, dorsal view.
4. *Heosemys leytensis* sp. nov.; from the type, ventral view.

PLATE 2

FIG. 1. *Cyclemys dhor* Gray; young, dorsal view, somewhat reduced.
2. *Cyclemys dhor* Gray; young, ventral view.
3. *Cyclemys amboinensis* (Daudin); young, dorsal view, somewhat reduced.
4. *Cyclemys amboinensis* (Daudin); ventral view.

PLATE 3

FIG. 1. *Heosemys leytensis* sp. nov.; head of the cotype, from Leyte, enlarged.
2. *Cyclemys amboinensis* (Daudin); ventral view of an old specimen, showing no serrations on the posterior border of the carapace.
3. *Cyclemys amboinensis* (Daudin); ventral view of a variety with the posterior border of the carapace serrated; reduced.

PLATE 4

FIG. 1. *Cyclemys dhor* Gray; dorsal view of a carapace in the Bureau of Science collection, with rather distinct posterior serrations.
2. *Cyclemys dhor* Gray; ventral view.
3. *Cyclemys dhor* Gray; a living specimen owned by Mr. W. Schultze, of Manila; dorsal view, reduced.
4. *Cyclemys dhor* Gray; ventral view, reduced.

PLATE 5

FIG. 1. *Eretmochelys imbricata* (Pennant); a young specimen from Aparri, Luzon; dorsal view.
2. *Eretmochelys imbricata* (Pennant); ventral view.

PLATE 6

FIG. 1. *Caretta olivacea* (Eschscholtz); a young specimen in the Bureau of Science aquarium; dorsal anterior view, reduced.
2. *Caretta olivacea* (Eschscholtz); ventral posterior view.
3. *Pelochelys cantorii* Gray; a living specimen, in the Bureau of Science aquarium; dorsal anterior view, reduced.
4. *Pelochelys cantorii* Gray; ventral posterior view.

FIG. 5. *Eretmochelys imbricata* (Pennant); a living specimen, in the Bureau of Science aquarium; dorsal anterior view, reduced.
6. *Eretmochelys imbricata* (Pennant); ventral posterior view.

PLATE 7

FIG. 1. *Chelonia japonica* (Thunberg); a living specimen, in the Bureau of Science aquarium; dorsal anterior view, reduced.
2. *Chelonia japonica* (Thunberg); ventral anterior view.
3. *Chelonia japonica* (Thunberg); young dorsal view.
4. *Chelonia japonica* (Thunberg); ventral view.

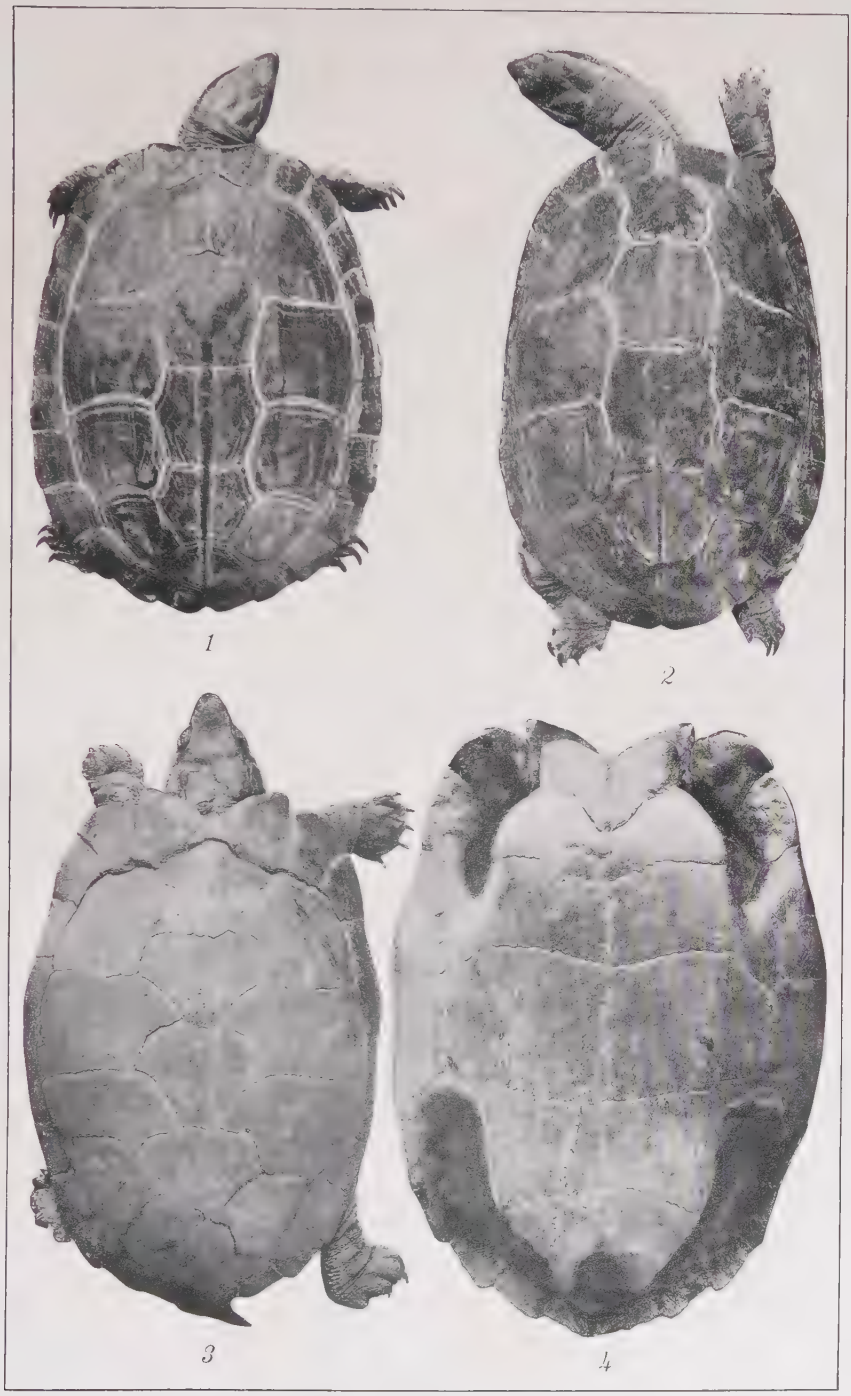

PLATE 1. PHILIPPINE TURTLES.

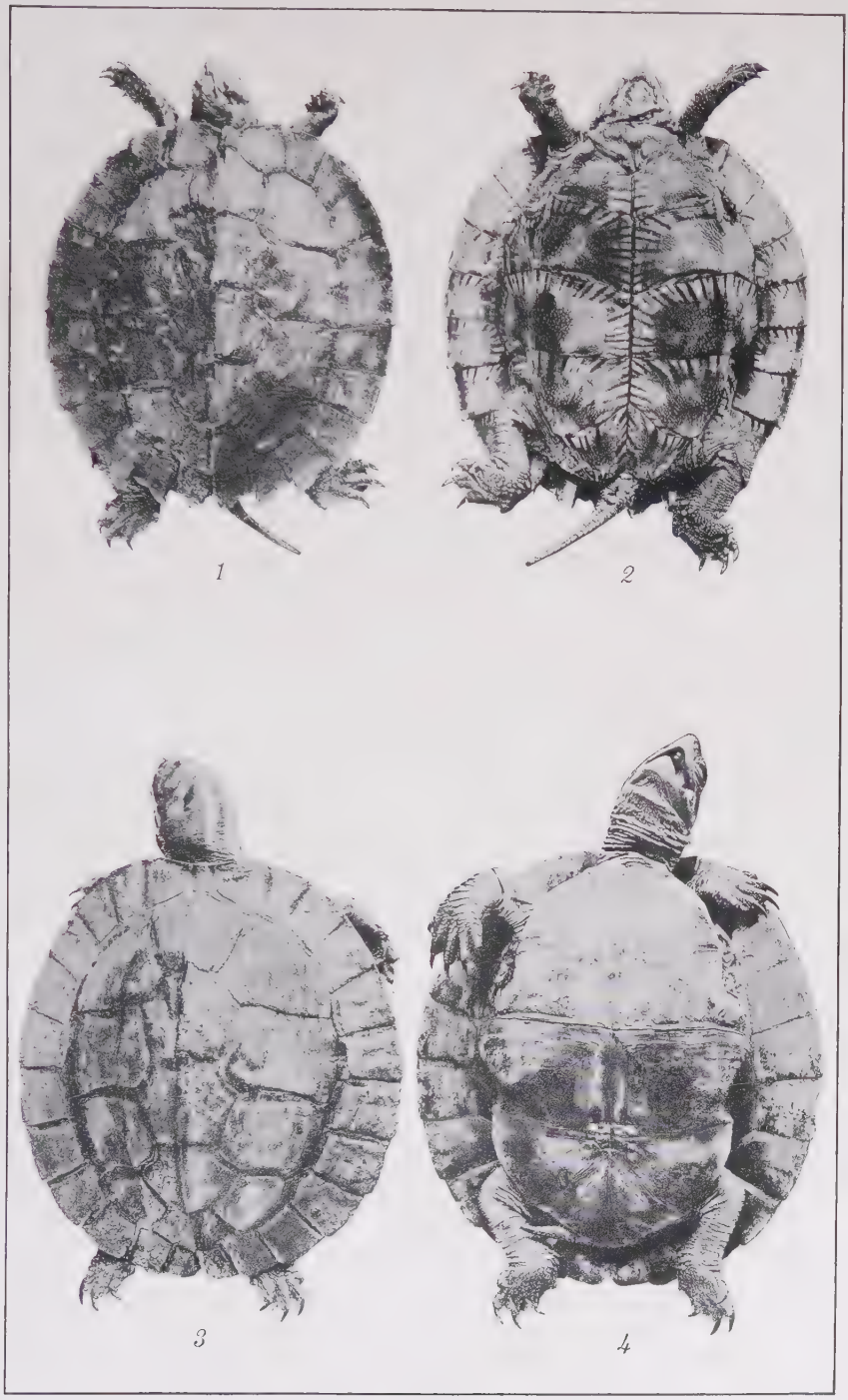

PLATE 2. TWO SPECIES OF CYCLEMYS.

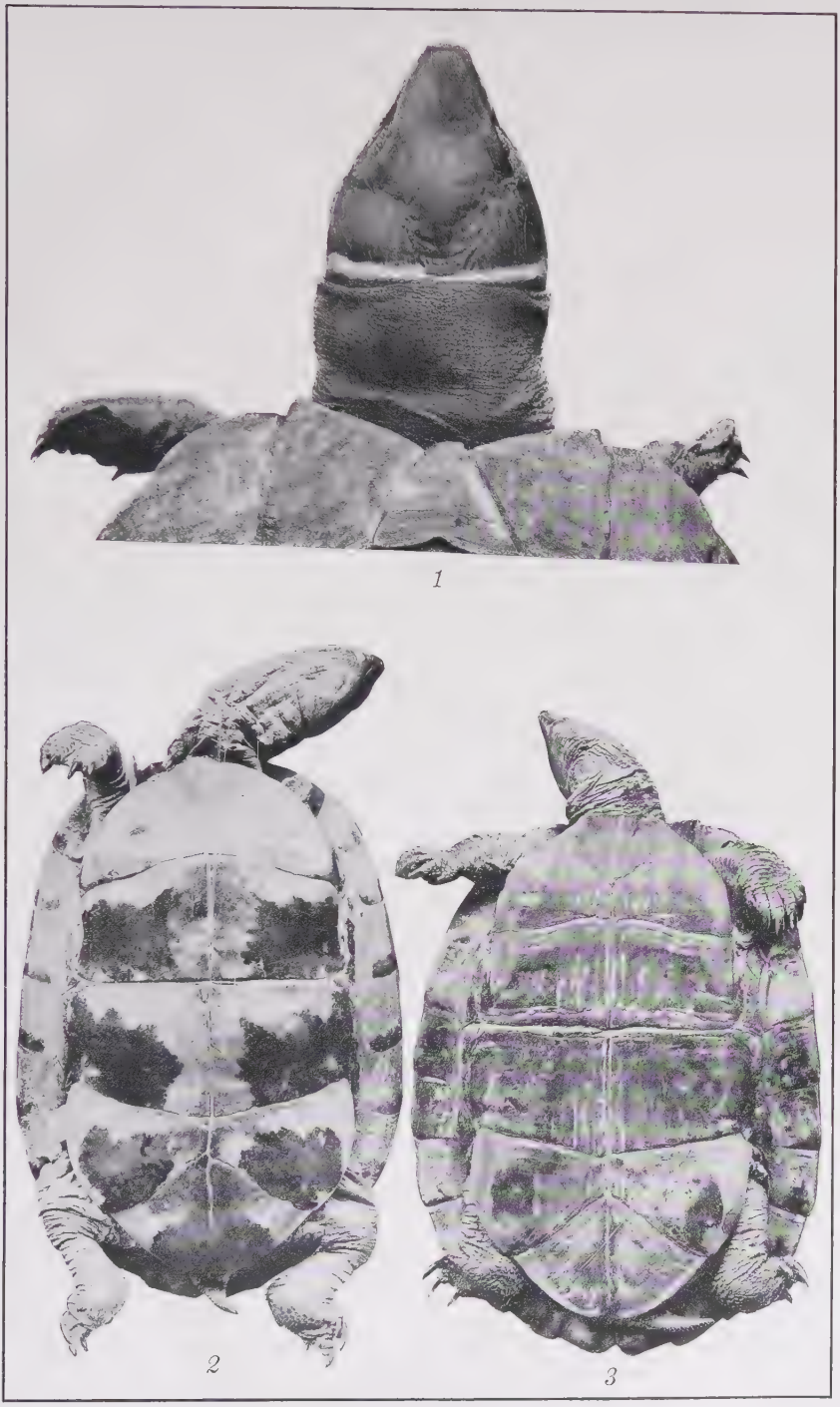

PLATE 3. PHILIPPINE TURTLES.

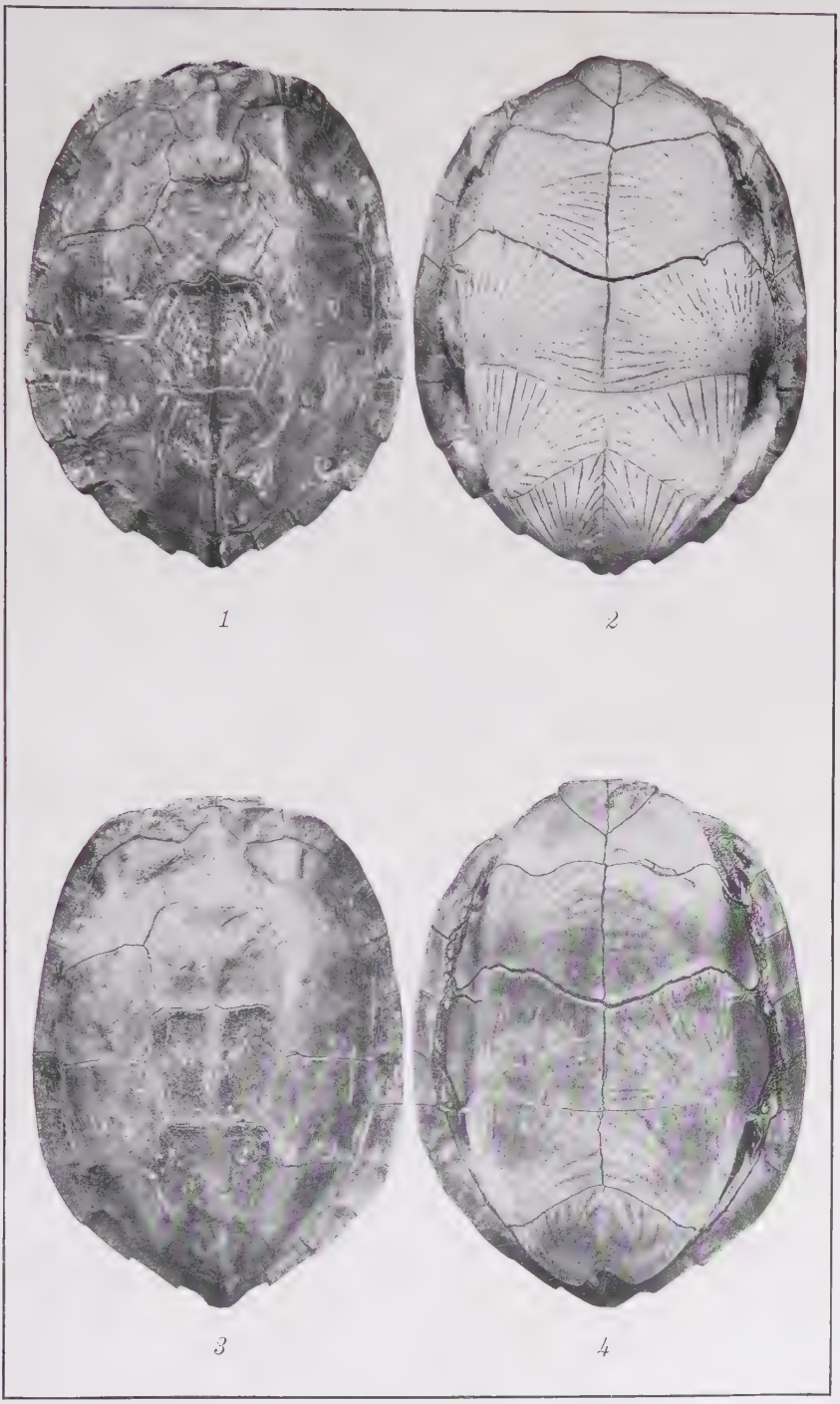

PLATE 4. CYCLEMYS DHOR GRAY.

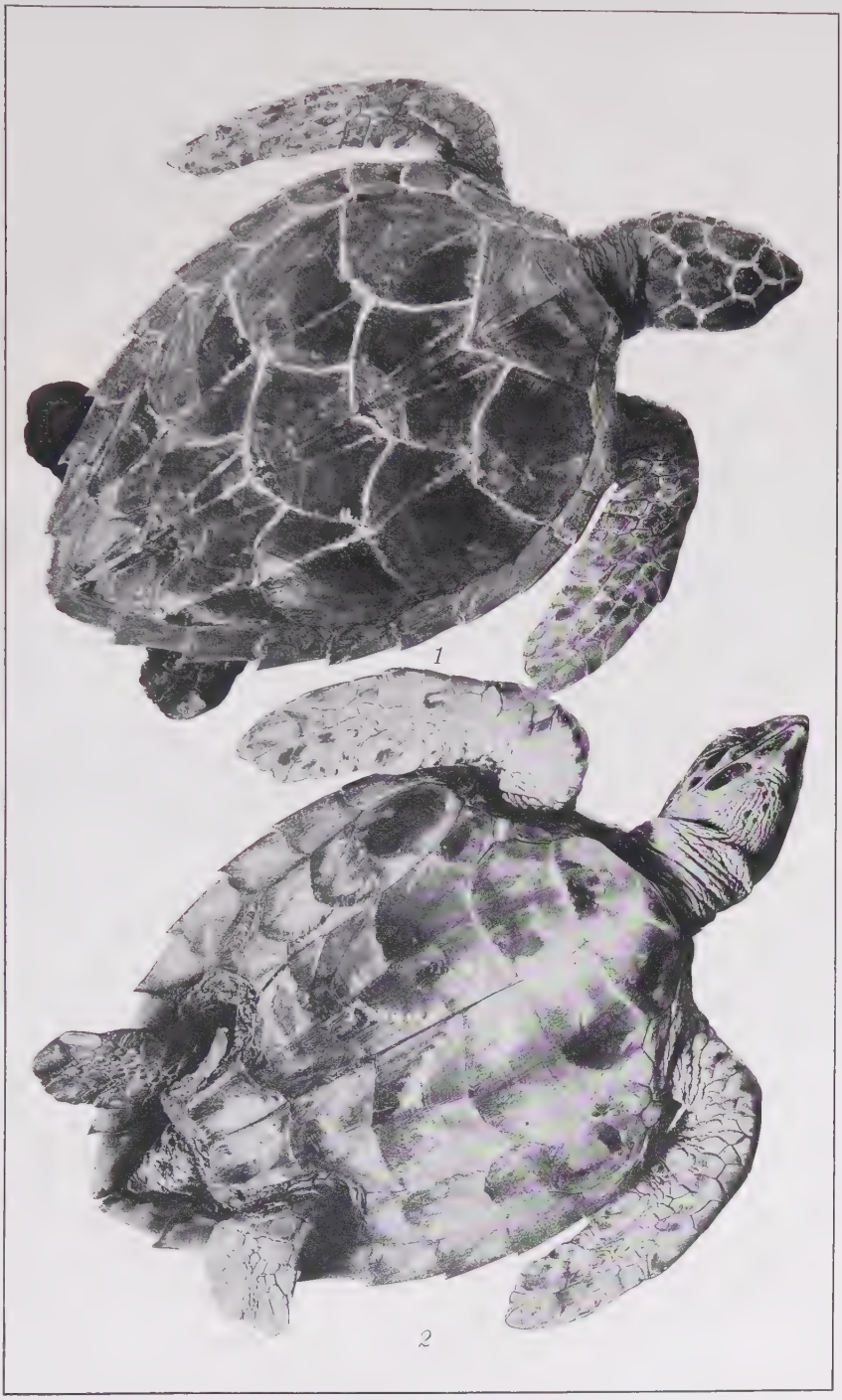

PLATE 5. ERETMOCHELYS IMBRICATA (PENNANT).

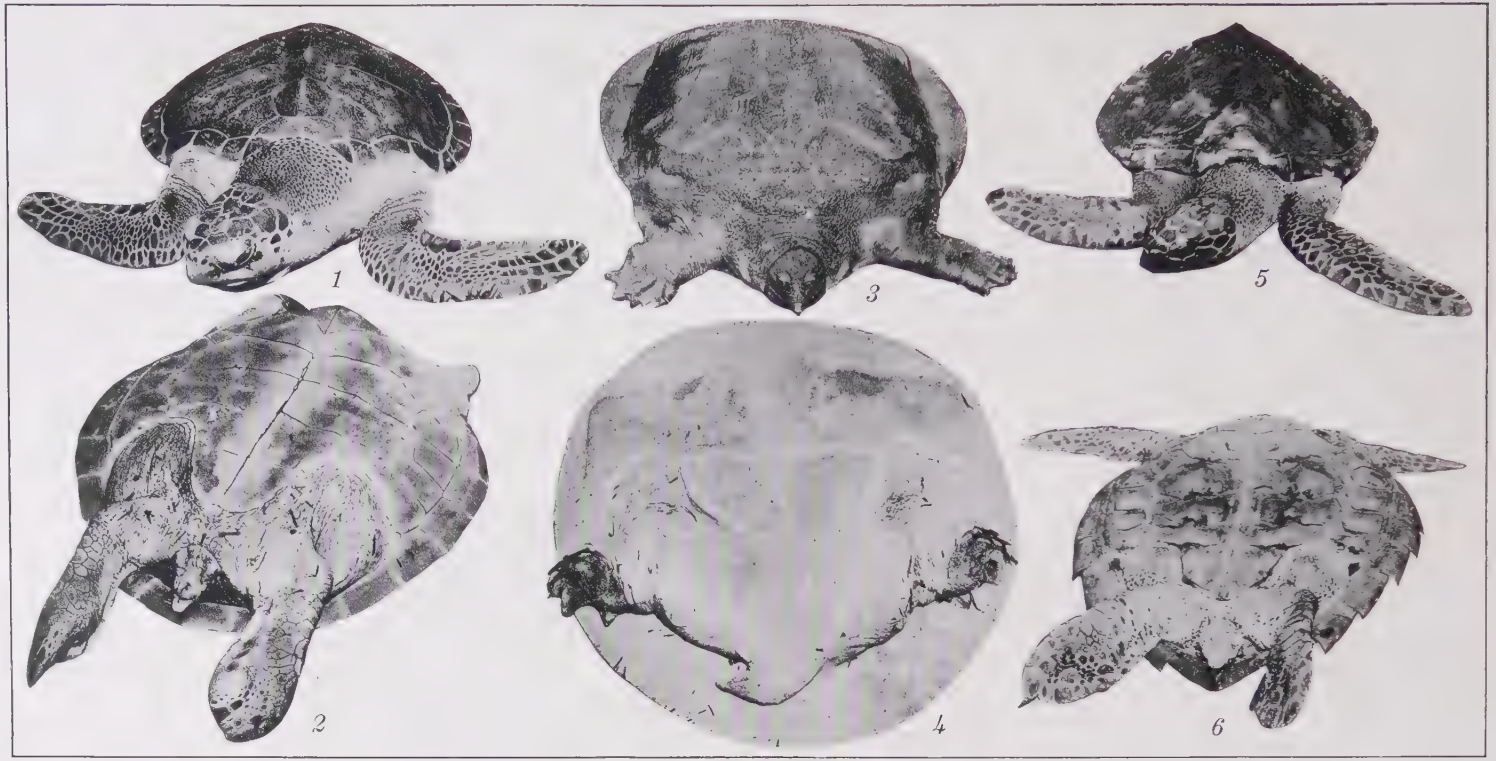

PLATE 6. PHILIPPINE TURTLES.

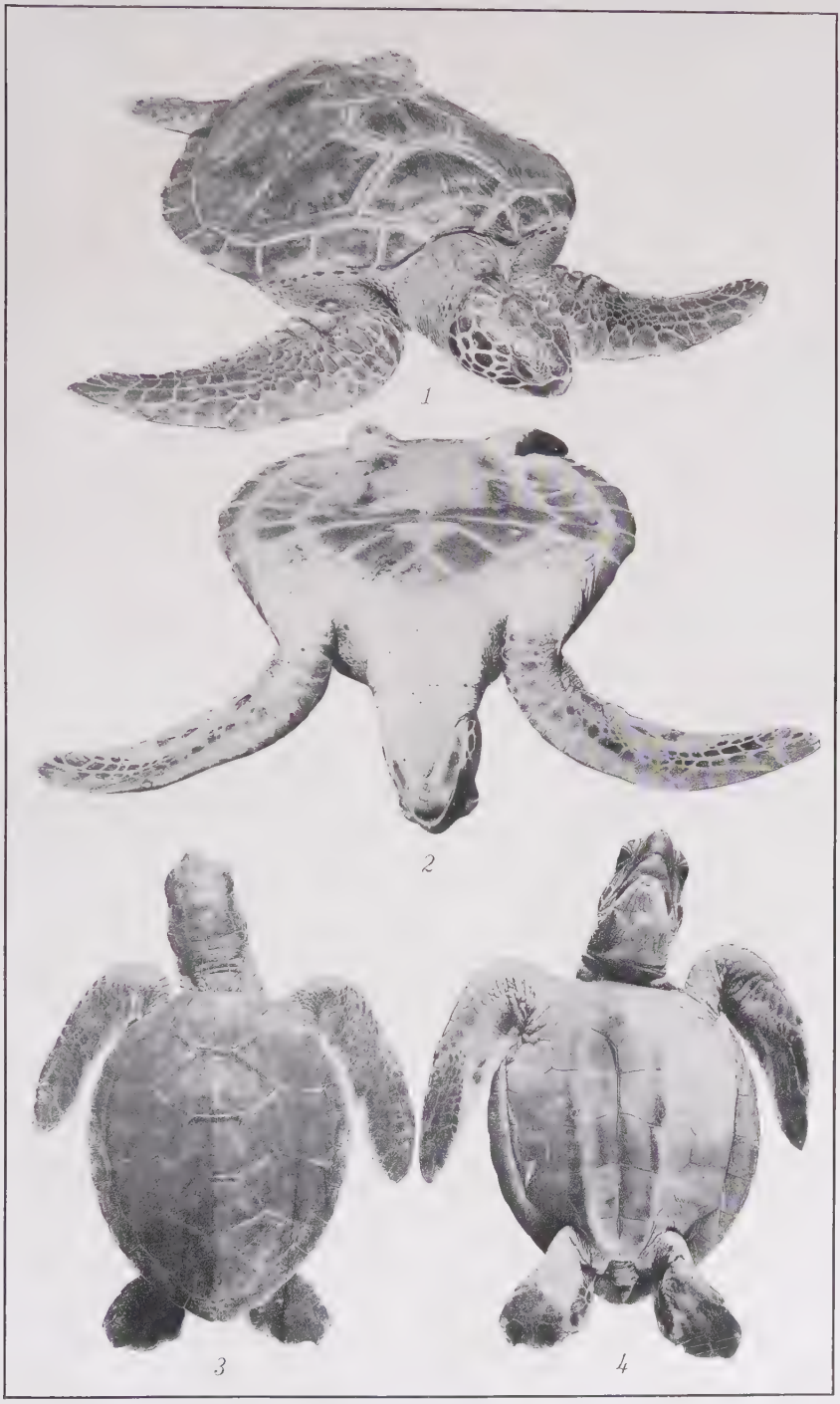

PLATE 7. CHELONIA JAPONICA (THUNBERG).

SOME BEES FROM PANAY

By T. D. A. Cockerell

Of the University of Colorado

During May, June, and July, 1918, Mr. R. C. McGregor collected insects at Culasi, on the west coast of Panay, and on Batbatan Island, off Panay. Many species of various orders were found, but the present report deals only with the bees.[1] Since no bees had been collected on Panay or Batbatan, the collection was examined with a lively expectation of novelties. It has been rather surprising to find only one new species, a very fine and distinct *Nomia* from Culasi. A *Megachile* from Culasi represents a new variety or subspecies, but with these two exceptions the insects all agree with those previously found in other islands of the Archipelago. Among the previously known forms, however, was the striking carpenter bee *Mesotrichia cuernosensis,* of which I had only a single female, from Negros. It is evidently common on Panay, and the male, previously unknown, was obtained. As in the case of several other species of *Mesotrichia,* it is very unlike the female in appearance; the thorax with orange-fulvous hair, and the abdomen appearing blackish green.

All that we know of Philippine bees shows that the lowland faunæ of the several islands are very much alike, and suggests that most of the islands have been connected in comparatively recent times. Even the apparent differences in the faunæ are probably due largely to the imperfection of our knowledge, though there are undoubtedly species which do not extend all over the Archipelago, and probably some at least are really peculiar to particular islands. It should be added that we know very little, comparatively speaking, of the upland bees, and these may be expected to show more precinctive types.

CULASI

Apis indica nigrocincta (Smith).

Thirteen workers.

[1] One of the most interesting of the other insects is a remarkable orthopteron looking like a small piece of wood, collected at Culasi. Mr. Rehn has kindly identified it for me as *Misythus cultatrix* (Walker).

Mesotrichia cuernosensis Cockerell.

Eighteen females; the anterior wings from 19 to 23.4 millimeters long. The smallest specimens, compared with the largest, look very different, but there are many intermediate sizes. Previously known from Negros. There are also three males which I can only associate with this species, of which the male has not been previously known. They are extremely like the male which I have referred to *M. bakeriana,* but are larger (anterior wing, about 20 millimeters), with rich orange-tawny hair on thorax above, median band on clypeus not reaching transverse band (which is narrow in middle), a well-defined tubercle just below clypeal margin, and labrum with yellow hair (tubercle absent and labrum fringed with copper-red hair in *bakeriana*). One female of this species was collected at Flores, a barrio near Culasi, at flowers of *Stachytarpheta jamaicensis* (Linn.) Vahl.

Mesotrichia latipes (Drury).

Seven females and three males. The wings are purple and green, the amount of purple varying. This species is widely distributed in tropical Asia. It nests in wood and may have been introduced in the Philippine Islands by man.

Mesotrichia major (Maidl).

Two males.

Ceratina tropica Crawford.

Two females.

Ceratina philippinensis Ashmead.

Ten females and nine males.

Ceratina sexmaculata Smith.

Two males and fourteen females. One female was taken at flowers of *Melastoma polyanthum* Blume on May 26.

Allodape marginata Smith.

Three females. One has the clypeal mark as in *A. mindanaonis,* and all have the hair of hind legs reddish. I think they all belong to the same species, but males are needed to make certain.

Crocisa crucifera Cockerell.

Twenty-one specimens. The abdominal markings vary from blue to greenish.

Anthophora korotonensis Cockerell. (*A. stantoni* Cockerell.)

Eleven females and ten males. One male at flowers of *Stachytarpheta jamaicensis* (Linn.) Vahl.

Nomada mindanaonis Cockerell.

One female. Previously known from Mindanao and Palawan. The abdomen of the Panay example is clear red, and the insect is larger than those from Mindanao.

Megachile subrixator Cockerell.

Three females.

Megachile hera Bingham.

Three females.

Megachile valdezi Cockerell.

Two females. One has long black hair at extreme sides of third and fourth abdominal segments, in the other this is hardly noticeable. The specimens agree with the type of *M. valdezi* in being considerably larger than *M. hera* or *M. subrixator*.

Megachile chlorura Cockerell.

One female.

Megachile metallescens Cockerell.

Two females.

Megachile mcgregori Cockerell.

One male. Differs from the type by having the hair bands at sides of abdominal segments 2 to 4 suffused with fulvous. This may be the male of *M. metallescens,* which occurs in the same two localities. The abdomen is not at all metallic; but otherwise, aside from the usual sexual differences, the insects are very much alike.

Megachile rufofulva Cockerell var. **panayensis** var. nov.

One female. Compared with the unique type from Mindanao, this is much more robust, with much broader thorax and abdomen, and with more black hair on front and scutellum. Probably a distinct subspecies is indicated, but more specimens are needed to prove the case. For the present we may designate the Culasi insect variety *panayensis* var. nov. The abdomen is like that of the Bornean *M. sandacana* Cockerell, but the thorax, seen from above, appears shining black.

The halictines from Culasi have been recorded in a previous paper but I add the names to complete the list.

Nesohalictus robbii (Crawford).

Halictus philippinensis Ashmead.

Halictus thoracicus sublustrans Cockerell.

Halictus thoracicus merescens Cockerell.

Halictus mcgregori Cockerell.

Nomia thoracica stantoni (Ashmead).

Fourteen specimens.

Nomia longitarsis Cockerell.

One female. The specimen has opaque pale yellowish bands on abdominal segments 1 to 4, and the stigma ferruginous. It thus differs both from the type and variety *eboris*, and possibly represents a distinct race.

Nomia levicauda Cockerell.

Two females.

Nomia quadrifasciata Ashmead.

Five males and twenty-seven females. Three of the five males are typical *N. quadrifasciata;* the other two have more dusky hind legs and approach var. *notha* (Cockerell). It is certain that *notha* is only a variation of *N. quadrifasciata.*

Nomia iridescens Smith.

One female. On *Melastoma polyanthum* Blume, May 27.

Nomia strigata (Fabricius) var. **ridleyi** Cockerell.

One female.

Nomia mcgregori sp. nov.

Female.—Related to *N. quadrifasciata,* but larger and more robust (anterior wing, 8 millimeters; width of thorax, about 4 millimeters); the blue-green bands on hind margins of abdominal segments 2 to 4 very narrow (hardly or not half as wide as in *quadrifasciata*); lobes of postscutellar process large, broad and obtuse; tegulæ entirely black; prothorax and tubercles with black hair, but conspicuously fringed with white tomentum; mesothorax with strong dense punctures (not of two sizes as in *N. incerta*), and with very short black hair, with a little intermixture of white, especially at sides; wings very strongly blackened, the stigma and nervures black; scutellum between the large scattered punctures dull; hind tibiæ with much black hair posteriorly; middle tibiæ beneath, and their femora beneath at base, with shining red hair.

One female. By the form of the postscutellar process related to *N. incerta* Gribodo, from Java, but the mesothorax is different.

BATBATAN ISLAND

The following were collected on Batbatan Island, June, 1918:

Ceratina philippinensis Ashmead.
Five females and one male.

Allodape marginata Smith.
One female. Pale clypeal band unusually broad.

Allodape cupulifera bakeri Cockerell.
One female.

Crocisa crucifera Cockerell.
One female.

Anthophora korotonensis Cockerell.
Two males.

Nomia quadrifasciata Ashmead.
One female and one male.

LOW-SUN PHENOMENA IN LUZON

By Willard J. Fisher

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TWO TEXT FIGURES

I. ZENITH OBSERVATIONS OF DAWN, MANILA, 1918–1919

By "low-sun phenomena" I mean those aspects of the sky and the atmosphere which are seen during the period of oblique or nearly horizontal illumination within a short time before and after sunrise or sunset; as the Zodiacal Light, dawn and twilight, crepuscular rays and shadows, colors of sky and clouds, and the color and form of the low sun itself. Related to these, though not all exactly solar in the origin of their light, are the phenomena of moonrise and moonset, of low stars, of the eclipsed moon, the Gegenschein, and atmospheric refraction at low altitudes—particularly horizontal refraction at sea level, when the rays of light are parallel to the ocean surface.

For the study of low-sun phenomena Luzon possesses certain advantages. It is subject to steady and well-studied tropical oceanic conditions of pressure and temperature; it is not so large but that the horizon, seen toward east or west from heights that are small compared with the air depths, would be a sea horizon; it has good roads and railway communications; it has been geodetically and topographically surveyed and mapped; there is a good meteorological and telegraphic standard time service centering in the Manila Observatory; many of its mountain peaks are considerably above the hazy low altitudes which extend to the strato-cumulus level, and some are reached by good trails—in one case, Santo Tomas, Benguet, there is a modest summit hotel.

The observations following were made mostly in Manila; where the point of observation was elsewhere, it is noted. This city, being the center of civilization and government, with excellent scientific libraries, has advantages in some ways over any other point in the Philippines; the open sea is only about forty miles away east or west, though the physical horizon east or west is mountainous; the sun, however, during a few weeks about the winter solstice sets in the water between Corregidor Island and Bataan Province; most stars of declinations between south

20° and south 40° always set in a sea horizon. The low situation of the city, formerly swamp land near the level of Manila Bay, subjects it to a maximum of atmospheric absorption; the factory and power-plant chimneys along Pasig River and the steamers in the harbor send out vast volumes of sooty smoke; during the dry season dust often fills the air; and a very good electric street-lighting system brightly illuminates smoke, dust, and low clouds overhead; so that opportunities for satisfactory observation of the delicate pale dawn, the Zodiacal Light, or the Gegenschein are none, and evening observations of twilight are usually worthless.

Nevertheless, being in the University of the Philippines at Manila, and finding that early rising in the balmy morning air is not the sad discomfort of 4 o'clock in New England, and finding also that the complete series of dawn phenomena is over in a fraction of the time it takes in latitude 42°, I have made observations during a year's clear weather on low-sun phenomena at Manila, hoping that even such amateur work may prove of some use in adding to our knowledge of the earth's atmosphere.

The "darkness of night" is of course only a relative term. The night is sometimes "as dark as a pocket" when the sky is overcast with rainy storm clouds; yet an overcast sky, in which no stars are visible and during the "dark of the moon," sometimes is bright enough for comfortable walking along a country road. The solely starlit sky, in clear weather, is far from dark; on the Benguet plateau, in April, 1919, I have been able to read the seconds dial of my watch, with the help of a pocket lens, by the light of the Galaxy and the stars from Scorpio to Cygnus. The total light of starlit hemisphere is quoted by Kimball [1] as somewhat in excess of that of a thousand stars of the first magnitude, or one two-hundred-and-fiftieth of the brightness of the full moon. Of course, this brightness is not evenly distributed, the Galaxy emitting a disproportionate amount, and atmospheric absorption cutting off much light of stars at low altitudes.

This starlit sky is not, however, always of the same dimness between the stars; there are times when it is distinctly pale.[2] This is not attributed to any terrestrial cause, but is as if the earth at times passes through regions of space which are lu-

[1] Kimball, H. H., Mo. Weath. Rev. 44 (1916) 620.

[2] Simon Newcomb quotes Barnard's word "milky." Zodiacal Light, Encyc. Brit. 11th ed. 28 (1911) 998–1000.

minous, either by emission or by the reflection (or scattering) of sunlight.

Near the plane of the ecliptic this brightness of the sky is concentrated in the Zodiacal Light. Under favorable circumstances this is seen clear across the heavens as an arch or band of light; at Manila and Batangas, both near sea level, I have seen it as far as the zenith with the sun an hour below the horizon. The Gegenschein is a faintly brighter spot in the Zodiacal Light, 180° away from the sun; I doubt if it is ever to be seen against the artificially bright sky of Manila. The Zodiacal Light widens toward the sun; it completely surrounds this, as is known by observations of Simon Newcomb and others, looking northward from suitable stations in the northern hemisphere, at about midnight near the summer solstice.

As the hour of dawn at Manila approaches, the Zodiacal Light broadens and brightens in its lower parts, so that stratus clouds show distinctly as dark bands across it. Then a pale light spreads upward from the east; in Manila this does not seem to start even at the physical horizon of mountains and clouds, but higher up, where atmospheric absorption exerts a less weakening effect on the Zodiacal Light. Whether this pale light is distinguishable from the Zodiacal Light or has a definitely terrestrial origin, I think cannot be settled at Manila; I watched carefully at Batangas, after sunset, February 22, 1919, but could not decide; I have had no other good opportunity. Some observers say the transition is continuous.

As this "pale dawn" rises toward the zenith the lower eastern sky begins to be brighter and even ruddy, and above that bluish. The pale dawn passes the zenith, and the blue dawn follows it over the heavens. Then there pass upward and sidewise the familiar and often-described colored arches and bands of morning twilight,[3] frequently with the bright streaks and blue bands radiating from the sun's position, known as crepuscular rays and shadows, followed by the appearance of the sun itself, and the daylight changes of the atmosphere.

Since the days of the Arabian Alhazen attempts have been made by various observers to determine a lower limit for the height of the atmosphere by observing the time when the pale light of twilight first appears or last disappears at the horizon.

[3] Mo. Weath. Rev. 44 (1916) 614 and following pages, contains full descriptions of these phenomena, original, translated, or abstracted; so also do the numerous books on meteorology.

The theory is given, for example, by Young,[4] who shows that if the observations give an altitude —18° for the sun at this stage of twilight, then the sensible reflecting power of the atmosphere vanishes at a height of about 40 miles, taking account of refraction. But this, he says, is lower than the limit given by the ignition of meteors, about 100 miles.

Wegener[5] says:

> Most observations of this sort have been made on the principal twilight arch, and give, as previously mentioned, a height of 70 km. for the boundary layer here considered. The individual values are brought together in the following table; the numbers give the angular depression of the sun for the moment at which the twilight arch just sinks below the horizon or rises above it.

TABLE 1[6]

Schmidt (Athens)	15.9°
Behrmann (Atlantic)	15.6°
Bravais (France)	16.0°
Hellmann (Spain)	15.6°
Liais (Atlantic)	17.8°
Möller (Atlantic)	17.5°
Bailey (Arequipa, Peru)	17.5°
Miethe and Lehmann (Assouan)	16.1°
Carlheim-Gyllenskjöld (Spitsbergen)	17.7°

> On a critical consideration of these numbers it becomes very probable that most of them are affected by a not unimportant systematic error; for the vapor laden lowest air strata, lying yet in shadow, cover the upper edge of the twilight arch when it is nevertheless above the horizon. In this connection it is very instructive to see that observations in the morning, when the lowest layers are usually more transparent than in the evening, give much more accordant results, as the following table shows.

	Evening	Morning
Spain	15° 20′	17° 52′
Assouan	14 54	17 21
Atlantic	18 18	17 22

> Consequently, if we assume about 17.4° as the most probable value, we get by approximate calculation a height of 74 km. for the upper limit of the light reflecting layers.

The nature of the systematic error is apparent when one considers that the sunlight received by the eye has first entered the atmosphere, passed obliquely downward to tangency at the earth's surface, then obliquely upward to high regions where it is reflected or deviated obliquely downward again through the at-

[4] Young, C. A., General Astronomy (ed. 1898) 67–69.

[5] Wegener, A., Zeitschr. f. anorg. Chem. 75 (1912) 112; Beiträge z. Geophysik 11 (1912) 104; and, somewhat fuller, Phys. Zeitschr. 12 (1911) 170–178 and 214–222.

[6] This is Table 1 of the present paper, not so numbered by Wegener.

mosphere to the eye of the observer, who sees it on its second tangency at the surface—three passages through the lower atmosphere, with a total absorption many times that in one such passage, even though there did not intervene the weak reflection by the upper air. In fact, the light actually observed passes along paths considerably higher and more transparent than those of the elementary theory, and the computed lower limit is based on an angular depression of the sun considerably too small.

Horizon observations of dawn are impossible at Manila, on account of all sorts of local conditions described above. But, on watching the passage of the various stages of dawn across the sky, I thought that the zenith passage of each stage might be observed with reasonable accuracy, a value deduced for the corresponding altitude (or depression) of the sun, and hence a better lower limit for the atmospheric extent.

Besides the fact that the zenith is more generally visible than the horizon, zenith observations have the evident superiority over horizon observations that they involve one less absorption during tangential passage of light through the lower air. The light deviated vertically downward passes the absorbing layer by the shortest possible path, though probably a deviation or scattering of 90° produces less intensity than one which is very small.

On the morning of April 18, 1919, looking in all directions from the summit of Mount Santo Tomas, Benguet, the low haze layer was fairly well defined. Arayat, an isolated volcanic cone in Pampanga Province, 1,024 meters high, did not project through it. The two eastmost peaks in Zambales Province, between the central plain and the sea, thrust dark blue summits above the haze, one only a little, the other quite a good deal. They are Negron, 1,590 meters, and Pinagtabo, 1,781 meters. So that, on this morning, the haze layer ceased at a height of about 1,500 meters. Assuming it uniform in height and turbidity—it really seemed somewhat more turbid in its upper parts—calling the earth's radius 6,371 kilometers (this is the mean of two equatorial radii and one polar), and neglecting refraction, light reaching a point on the surface horizontally would have traversed the haze a distance of

$$\sqrt{2\times 1.5\times 6{,}371}=138.3 \text{ kilometers};$$

and if it is reduced to the fraction n of its intensity by absorption when passing through vertically, it would be reduced after horizontal passage to $n^{138.3/1.5}$ of its original intensity. For the whole atmosphere it has been estimated that vertically incident light

is 79.4 per cent to 89.0 per cent transmitted;[7] to anyone looking down at the lower haze from a mountain, it seems as if most of the absorption must occur in the last 2 kilometers. Looking from Santo Tomas northwest over the China Sea on the morning mentioned, cumulus clouds were forming low over the water, and some of these were growing large enough to push their summits through the haze. The contrast in brightness between these white summits and the ruddy banks in the haze was extraordinary.

Suppose that 85 per cent is transmitted vertically by the whole atmosphere, and that one-third of the 15 per cent absorption occurs in the haze layer; the latter I will assume of uniform absorbing power and negligible refraction. Then the haze layer transmits n=94.45 per cent of any light normally incident upon it, and horizontal light, from incidence to tangency, is 0.5 per cent transmitted. Light passing in and out clear through the haze layer and tangent to the earth's surface is 0.003 per cent transmitted. The effect of refraction is to lengthen the path of absorption and so diminish the proportion transmitted.

Attempts to observe the passage of the pale dawn led to discordant results, as is natural, considering the artificial illumination of the Manila sky and the uncertain relation of this phase to the Zodiacal Light. But I found that the appearance of the first tint of blue at the zenith gave solar depressions which were variable, to be sure, but for similar conditions of the sky were fairly concordant; and this is quite surely a terrestrial phenomenon.

The only apparatus used was a watch, whose error was regularly determined at noon by the fall of the time ball of the Manila Observatory. This ball is dropped at 12 noon on signal from the standard clocks of the observatory, which are regularly compared with the transits of stars. In 1916 the maximum error in starting the time ball is reported[8] as 0.5 second, and the average error as less than 0.2 second, which shows what precision to expect in general. The going of this watch was

[7] Kayser, Handbuch der Spectroscopie 3 (ed. 1905) 341, gives a table of nine such values. More modern data would alter the following computations considerably, but they may serve for illustrations.

[8] Annual Report of the Weather Bureau for 1916. My own star observations, entirely independent of the Observatory, justify confidence in this time ball.

also carefully studied at various times by comparison with the large clock of the University physics department, which was also regularly compared with the time ball. I think that uncorrected errors in the standard time of an observation were never over 5 seconds. For reading the watch at night a pocket lens and the light of a distant street lamp were used. This simple equipment is precise enough for the determination of so unsharp a phenomenon as the appearance of a recognizable blue in the neighborhood of the zenith.

While precision in the determination of the zenith is in the nature of the case unnecessary, nevertheless I experimented to see how accurately I could determine it. Thus, I faced northward and looked upward and estimated the position of the zenith among known stars; then faced southward and estimated again. Halfway between two such estimated positions was used to compute the latitude of the observing point, by finding the declination of the zenith on star maps in Winslow Upton's Star Atlas. The results of various trials were as follows:

	°	′
(1) α Pegasi indistinguishably near zenith	14	46
(2) γ Pegasi indistinguishably near zenith	14	44
(3) Interpolation, Saturn and η Leonis	15	13
(4) Interpolation, ε Virginis and 42 Comae	14	39
(5) Interpolation, α Tauri and c Tauri	14	18
(6) Interpolation, ζ Tauri and λ Orionis	14	52
(7) β Leonis indistinguishably near zenith	15	1
Mean declination of zenith	14	48
True latitude, about	14	35.4

Table 2 shows the year's results for the zenith passage of the blue dawn, computed with the American Nautical Almanac and four-place logarithms for a point in Manila, latitude north 14° 35.4′, longitude east $8^h\ 3^m\ 54^s$. The accuracy of tenths of minutes, or even minutes, is of course illusory; but an attempt to apply principles of the precision of measurements was not regarded worth the trouble. No observations were attempted with the moon up. Under approximately similar conditions, within a few days of one another results would agree within 15′ or 20′, about the sun's semidiameter.

Fault may be found with zenith observations of twilight, that the blue light may come, not from exceedingly high air directly illuminated by sunlight, but from air indirectly illuminated by light reflected from the distant atmosphere and also from high clouds beyond the horizon.

TABLE 2.

Date.	Hour E. 120°.	Altitude of sun (center).	Sidereal time.	Remarks.
1918.	*H. m. s.*	° ′	*H. m.*	
October 7	4 53 26	−13 33.8	6 0	
October 8	4 58 38	−12 10.4	6 9	
October 9	4 53 2	−13 42.1	6 7	
October 14	4 53 53	−13 37.2	6 28	Full moon, October 20.
November 4	4 57 43	−13 38.0	7 55	Full moon, November 18.
December 9	5 18 48	−12 9.6	10 34	
December 10	5 18 21	−12 23.2	10 37	
December 11	5 19 7	−12 20.0	10 42	
December 16	5 18 14	−13 45.0	11 1	Full moon, December 18.
1919.				
January 8	5 28 5	−13 15.4	12 38	
January 11	5 28 32	−13 22.1	12 50	Full moon, January 16.
February 10	5 23 35	−14 44.3	14 43	
February 12	5 24 28	−14 24.1	14 52	Full moon, February 15.
February 22	6 56 16	−13 41.8	5 6	Evening, Batangas.
March 4	5 16 53	−13 59.6	16 2	Full moon, March 16.
April 4	4 53 25	−14 34.1	17 42	
April 5	4 54 32	−14 8.0	17 47	
April 10	4 54 17	−13 16.8	18 5	Baguio. Full moon, April 15.
April 30	4 34 21	−14 46.7	19 5	
May 1	4 36 48	−14 4.1	19 12	
May 2	4 36 43	−13 57.3	19 12	
May 4	4 37 53	−13 26.0	19 26	
May 5	4 33 56	−14 12.8	19 25	
May 8	4 34 12	−13 47.9	19 37	
May 11	4 34 57	−13 18.3	19 49	Full moon, May 15.
May 30	4 28 51	−12 30.7	20 58	
June 2	4 26 3	−13 54.1	21 7	
June 4	4 24 19	−14 6.1	21 3	Full moon, June 14.
October 1	4 50 42	−14 5.9	5 29	
October 2	4 50 49	−14 6.7	5 33	Full moon, October 9.

Of course this objection applies also to horizon observations of dawn, and with even greater force, because light is passed on by scattering with greater intensity if the deviation is small, as stated by Rayleigh.[9] The reflecting power, as well as the absorbing power, of the air is of course greatest in the lower region, up to the strato-cumulus level, in most latitudes about 2 kilometers high. The time of first visibility of cirrus clouds near the zenith, and their height—much greater than 2 kilometers—may assist in evaluating this objection, for their reflecting power is much greater than that of the thin air where they float or that of the much thinner and dryer air above them

[9] Phil. Mag. VI 36 (1918) 445, quoted in a critical note by J. Larmor, Phil. Mag. VI 37 (1919) 161.

in the isothermal region and higher, and they catch light sooner than anything at 2 kilometers.

The importance of this sort of observation did not occur to me at first. But the following notes were made and are here recorded in Table 3. The times given are watch times, uncorrected.

TABLE 3.

Date.	Time.	Remarks.
1919.	*H. m. s.*	
April 5	4 54 45	Zenith blue.
Do	5 00 40	Could see a pale cirrus about 30° elevation about halfway in the W. side of the Square of Pegasus.
May 2	4 34 30	Zenith pale blue.
Do	4 51 00	Cirrus evident as pale spot in east at estimated 45° altitude.
May 4	4 38 20	Zenith pale blue.
Do	4 50 00	Cirrus visible in east up to estimated 45° altitude.
May 5	4 34 15	Zenith pale blue.
Do	4 37 30	Cirrus visible in east up to estimated 20°.
May 30	4 29 40	Zenith pale blue.
Do	4 37 00	Cirrus streak between α and γ Cassiopeiæ. Altitude computed 30° 23′.
June 2	4 27 20	Zenith pale blue. A little before this (perhaps a minute, my attention was on the zenith), the high overflow in the east from a cumulo-nimbus was dimly visible as brighter than the sky at one edge, about 2° lower than α Arietis, or about 18° computed altitude.

It would seem then that cirrus and cirro-stratus clouds, whose average height at Manila is 10.9 kilometers (extremes, 4 and 18 kilometers), become visible as brighter than the sky at altitudes of 20° to 40° in the east from 6 minutes to 16.5 minutes later than the blue appears at the zenith; but that the very dense overflow from a cumulo-nimbus may become visible as brighter than the sky at about the same altitudes nearly simultaneously with the zenith blue. Hence I conclude that probably the blue of the zenith comes from direct sunlight, not from twilight reflected from air much higher than cirrus clouds, and certainly not from the hazy lower air.

The mean of all the values of the sun's altitude given in Table 2 is 13° 38.1′. I do not, however, consider this the most probable value, as the effect of most elements involved in a morning observation—such as fall of the time ball, comparison with the watch, hesitation over the appearance of the blue tint, delay in reading the watch, the nearness of the Galaxy and the Zodiacal Light, the existence of thin clouds or haze unobservable in the

dark—is to *postpone*. The year's experience shows that the more favorable the conditions, the greater the computed depression of the sun. Fig. 1 attempts to show some of the relations graphically. The abscissas are the sidereal times corresponding to the standard (east 120°) times of observation; the ordinates are, for curve 1, minimum distances of the ecliptic from the zenith of Manila, expressed crudely by measuring in millimeters on the star map accompanying the American Nautical Almanac; for curve 2, distances of the Galaxy east of the zenith of Manila, taken from Winslow Upton's Star Atlas, and expressed roughly

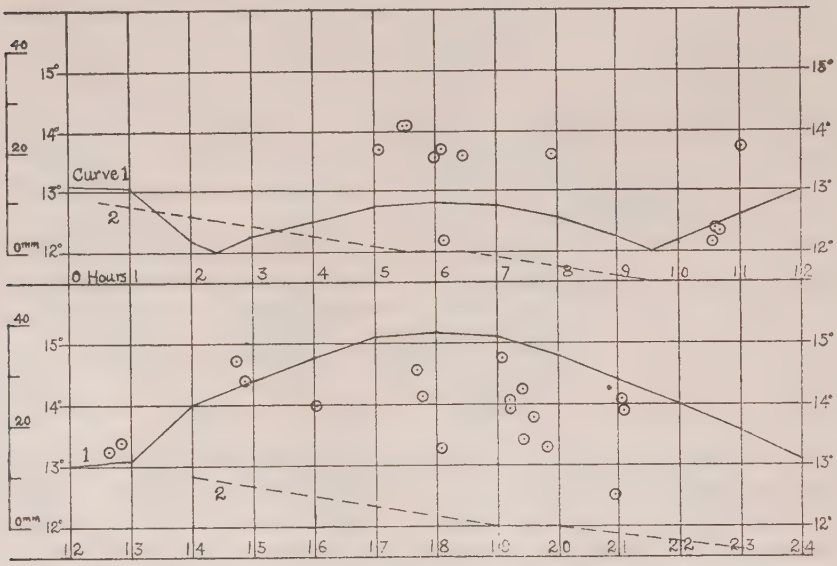

FIG. 1. Relation of computed results to zenith distances of the Zodiacal Light and the Galaxy.

in hours of right ascension. The plotted points show the depression of the sun in degrees. Since the axis of the Zodiacal Light lies near the ecliptic, the ordinates of curve 1 express roughly the distance of this from the zenith. It was found that greater distances of the Zodiacal Light, and clear weather free of cirrus clouds, gave large values of depressions; the nearness of the Galaxy had not so much importance.

These large depressions, over 14°, were quite unexpected; in fact, before computing in two or three cases I had supposed my recognition of the blue color to be tardy. For all these reasons I consider them more probable than any others, and the largest of them, 14° 46.7′, as the most probable.

In applying this result to the question of atmospheric height, a value of horizontal refraction at sea level must be used, as

the sunlight, which passes overhead at the moment of passage of the blue dawn, has been refracted and its lowest rays have been tangent to the sea surface some 700 sea miles east of Manila, and have suffered refraction nearly equal to twice the horizontal refraction at the point of tangency. On account of the near constancy of pressure and temperature conditions east and west in the Tropics, the most scientific way would be to observe the sun rising from the ocean and thence compute the refraction. As this is impossible, I have had recourse to monthly and yearly means of pressure and temperature at Manila, and have computed mean values of the horizontal refraction from them, hoping that the effect of land may be partly neutralized by the nearness of Manila Bay and Laguna de Bay.

TABLE 4.

Month.	Pressure.[a]	Shade temperature.[a]	Relative humidity.[a]	Vapor pressure.[a]	Horizontal refraction.	
					Pulkowa.[b]	Radau.[c]
	mm. Hg.	°C.	*Per cent.*	*mm.*	′	′
January	761.15	24.9	78.1	18.1	32.1	31.4
February	61.25	25.3	73.9	17.5	31.9	31.4
March	60.54	26.6	71.5	18.1	31.3	31.1
April	59.42	28.1	69.7	19.4	30.7	30.8
May	58.35	28.4	76.0	21.6	30.4	30.7
June	57.92	27.9	80.8	22.3	30.4	30.9
July	57.24	27.0	84.8	22.4	30.4	30.9
August	57.33	27.0	85.0	22.4	30.5	30.9
September	57.42	26.8	85.8	22.4	30.7	30.9
October	56.85	26.7	83.7	21.6	31.4	31.0
November	59.36	25.9	82.5	20.3	31.8	31.2
December	60.35	25.2	81.3	19.2	32.1	31.4
Year	759.08	26.6	79.4	20.4	31.37	31.04

[a] Averages over the period from 1885–1916, taken from the Annual Report of the Weather Bureau (1916).

[b] Computed from the abridged Pulkowa refraction tables contained in Campbell's Elements of Practical Astronomy, second edition.

[c] Computed from the refraction tables contained in Connaissance des Temps (1917). It will be noted that the Radau values are more uniform than the Pulkowa. In computing I use the former.

The pressures given in Table 4 are reduced to standard gravity before computing by subtracting from each 1.72 millimeters.

A formula for the calculation is derived as follows: In fig. 2, O is the earth's center, R its radius, Z the zenith of the observer, ST the direction of a ray before refraction, TV its direction after refraction, r the horizontal refraction; so that the angle ZTV, the deviation of the ray, is $2r$. The ray of course passes in a

curve through the atmosphere and is tangent to the earth's surface immediately under T; but its initial and final directions intersect at T, at height p above the earth; the ray passes under Z at a height H above the earth; h is then the geometrical altitude of the sun's upper limb (here negative, a depression).

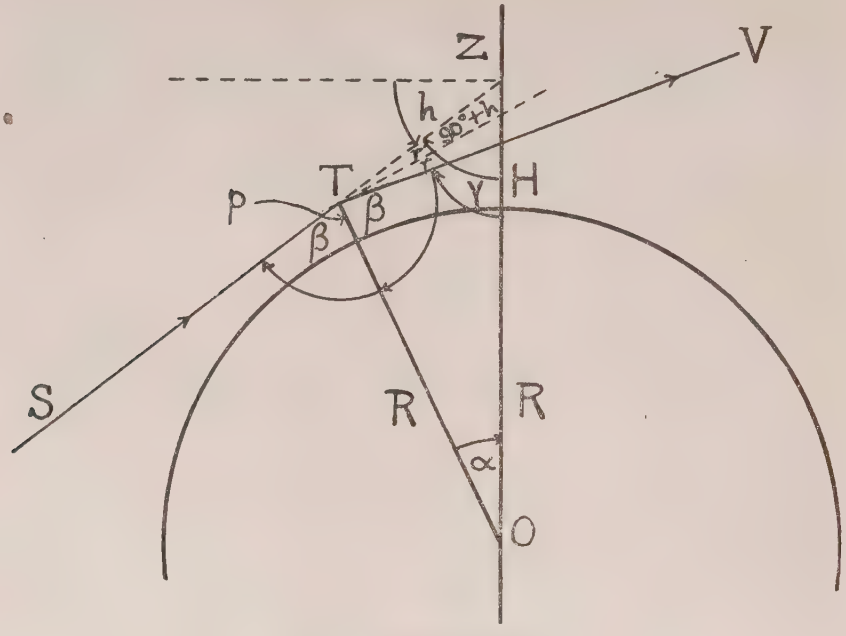

FIG. 2. Geometrical relations.

Clockwise arrows indicate positive angles, α, β, γ; the arrow for h, a negative angle, is counterclockwise.
From the figure

$$2\beta=180°-2r,\ \gamma=2r+90°+h,\ \alpha+\beta+\gamma=180°;$$

whence

$$\beta=90°-r,\ \gamma=90°+h+2r,\ \alpha=-(h+r),$$

and the angles of the triangle are determined. Of the sides none is given, but

$$(R+H)/(R+p)=\sin\beta/\sin\gamma,$$

or

$$(1+H/R)/(1+p/r)=\cos r/\cos(h+2r).$$

Now it is evident that the straight line TV is nowhere in contact with the earth; the perpendicular to it from the center is greater than the radius, or

$$(R+p)\ \sin\beta > R, \text{ or } (1+p/R) > \csc\beta,$$

which makes $1+p/R=\csc\beta$ a condition for a minimum value of $1+H/R$.

Substituting, $1+H/R \geqq \sec(h+2r)$, and $H \geqq R\,[\sec(h+2r)-1]$.

Taking now

	Average, year.	Best, IV 30.
	° ′	° ′
Altitude of sun's center	−13 38.1	−14 46.7
Semidiameter of sun	16.0	15.9
Twice horizontal refraction	1 2.1	1 1.5
$h+2r=$	−12 20.0	−13 29.3
Taking R 3,959 miles	$H \geqq$ 92.8 miles	112.9 miles
Taking R 6,371 kilometers	$H \geqq$ 149.3 kilometers	181.6 kilometers

The heights thus obtained are evidently the heights at which the lowest sunlight passes above the observer, or minimum values for the lower air at the point of tangency free of turbidity and clouds. The actual turbidity complicates matters somewhat, as practically no light passing tangent to the earth's surface is transmitted clear through a 1.5 kilometer haze layer with 94.45 per cent vertical transmission, as shown above; and so the light visibly illuminating the high air has passed horizontally through the atmosphere at a variable and uncertain elevation in or above the haze, with refraction also variable. Variability in these conditions probably helps to explain [10] variability in the computed depressions of the sun.

Further, light passed through the haze layer is weak in short wave lengths, being yellow or rose (or even redder, as often seen in the eclipsed moon), so that it can cause little scattering of blue when it goes on through the upper air.

For every reason it is probable that the computed solar depressions are appreciably smaller than would be obtained with an unturbid lower atmosphere and a starless, dark firmament.

Conclusions based on the optical properties of the atmosphere may be compared with those derived from the ignition of shooting stars, as they come plunging from the high vacuum of inter-

[10] I make this remark purposely somewhat indefinite, having in mind the change in color of mountain snow and cumulo-nimbus summits from rose to gray, which frequently occurs in a few seconds.

planetary space into the outer air. Various observers have deduced for the height at which they appear values ranging from 112 kilometers, for the slow Perseids of August, to 155 kilometers, for the swift Leonids of November; 180 kilometers is given as the average result of work at the Berlin Observatory, and even 200 kilometers by an English observer. These heights may be compared with the heights of 149.3 kilometers (average) and 181.6 kilometers (best) found above.

Neither the optical nor the meteor results give the extent of the atmosphere. The observations on dawn show that above the computed height there are enough molecules to scatter light in total sufficient to influence the eye; the meteors go a long way through the vacuumlike outer atmosphere before they become incandescent. But it would seem that the amount of the outer air which is competent to produce the one effect is also competent to produce the other.

For the loan of books and for friendly criticism of this paper thanks are due to Father J. Comellas, of the astronomical department of the Manila Observatory.

ILLUSTRATIONS

TEXT FIGURES

HIGHER BASIDIOMYCETES FROM THE PHILIPPINES AND THEIR HOSTS, II

By Otto A. Reinking

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The following list of fungi is a continuation of the identifications of the higher Basidiomycetes collected on Mount Maquiling and in the vicinity of Los Baños, Laguna Province, Luzon, in Mindanao, and in Sulu, as indicated in the text, these collections having been made with special reference to the identity of the host plants. Numerous extremely important timber-destroying forms are included. The collections have been made either by me or by my students under my direction. The determinations of fungi given in this list were made by C. G. Lloyd, of Cincinnati, Ohio. The species of fungi are grouped according to the classification of Engler and Prantl, with the host and the collector under each species of fungus. The numbers refer to the College of Agriculture fungus herbarium.

AURICULARIACEAE

AURICULARIA Bulliard

AURICULARIA AURICULA-JUDAE (Linn.) Schroet.

Alstonia scholaris R. Br., Mount Maquiling, *Reinking 2850,* on dead wood.

Caesalpinia sappan Linn., Mount Maquiling, *Reinking 2796,* on dead wood.

Capparis sp., Mount Maquiling, *Reinking 2737,* on dead wood.

Evodia sp., Mount Maquiling, *Reinking 2765,* on dead wood.

Melia azedarach Linn., Mount Maquiling, *Reinking 2819,* on dead wood.

Pterocarpus echinatus Pers., Mount Maquiling, *Reinking 2839,* on dead wood.

Streblus asper Lour., Mount Maquiling, *Reinking 2769,* on dead wood.

AURICULARIA CORNEA Ehrenb.

Alangium chinense (Lour.) Rehd. (*Alangium begonifolium* Baill.), Los Baños, *Reinking 3789,* on dead wood.

Mallotus moluccanus (Linn.) Muell.-Arg., Los Baños, *Reinking 3725*, on dead wood.

Pterocarpus indicus Willd., Mount Maquiling, *Reinking 2789*, on dead wood.

Vitex negundo Linn., Los Baños, *Reinking 3682*, on dead wood.

AURICULARIA DELICATA Fr.

Los Baños Falls, *Ocfemia 3560*, on rotting log.

AURICULARIA MESENTERICA (Dick.) Fr.

Mount Maquiling, *Cazeñas 973*, on dead wood.

AURICULARIA MOELLERI Lloyd.

Mount Maquiling, *Baybay 3404*, *Marquez 3313*, on dead wood.

AURICULARIA ORNATA Pers.

Mount Maquiling, *Cazeñas 801*, on dead wood.

AURICULARIA POLYTRICHA (Mont.) Sacc.

Parkia javanica (Lam.) Merr. (*Parkia timoriensis* Merr.), Los Baños, *Reinking 3672*, on dead wood.

TREMELLACEAE

SEBACINA Tulasan

SEBACINA sp.

Crescentia cujete Linn., Mount Maquiling, *Reinking 3132*, on dead wood.

TREMELLA Dillineus

TREMELLA FOLIACEAE Fr.

Macaranga tanarius (Linn.) Muell.-Arg., Mount Maquiling, *Santos 2602*, on dead wood.

TREMELLA sp.

Mount Maquiling, *Cazeñas 3307*, on dead wood.

DACRYOMYCETACEAE

GUEPINIA Fries

GUEPINIA SPATHULATA Schw.

Parashorea plicata Brandis, Mount Maquiling, *Reinking 2981*, on bridge railing.

THELEPHORACEAE

CORTICIUM Persoon

CORTICIUM sp.

Alangium chinense (Lour.) Rehd., Los Baños, *Reinking 3790*, on dead wood.

Lagerstroemia speciosa Pers., Los Baños, *Reinking 3727*, on dead wood.

Psychotria manillensis Bartl., Los Baños, *Reinking 3721*, on dead wood.

Tectona grandis Linn. f., Los Baños, *Reinking 3678*, on dead wood.

PENIOPHORA Cooke

PENIOPHORA sp.

Mallotus philippensis Muell.-Arg., Los Baños, *Reinking 3747*, on dead wood.

HYMENOCHAETE Léveillé

HYMENOCHAETE sp.

Evodia sp., Los Baños, *Reinking 3698*, on dead wood.

Lagerstroemia speciosa Pers., Mount Maquiling, *Reinking 2746*, on dead wood.

ASTEROSTROMA Massee

ASTEROSTROMA sp.

Elaeis guineensis Jacq., Mount Maquiling, *Reinking 2754*, on dead wood.

STEREUM Persoon

STEREUM CINERESCENS Schw.

Mount Maquiling, *Reyes 2974*, on dead wood.

STEREUM HIRSUTUM Fr.

Shorea guiso Blume, Mount Maquiling, *Reinking 3000*, on bridge flooring.

STEREUM INVOLUTUM Kl.

Gliricidia sepium (Jacq.) Steud., Mount Maquiling, *Nantes 2605*, on dead wood.

STEREUM NIGROPUS Lloyd.

Mount Maquiling, *Pañganiban 3379*, on dead wood.

STEREUM OSTREUM Nees (or *Stereum lobatum* Swartz).

Cryptocarya sp., Zamboanga, *Babao 447*, on decaying wood.

STEREUM SPECTABILE Kl.

Mount Maquiling, *Esguerra 875*, on dead wood.

THELEPHORA Ehrhart

THELEPHORA RADICANS Berk.

Bambusa sp., Mount Maquiling, *Reyes 2565*, on dead roots.

CLADODERRIS Persoon

CLADODERRIS INFUNDIBULIFORMIS Kl.

Mount Maquiling, *Baybay 749*, on dead wood.

CYPHELLA Fries

CYPHELLA FUSCO-DISCA Cooke.

Arenga pinnata (Wurmb) Merr., Los Baños, *Reinking 3719*, on dead petiole.

Casuarina equisetifolia Linn., Mount Maquiling, *Reinking 3067*, on dead wood.

CYPHELLA MELLEA Burt.

Erythrina fusca Lour., Mount Maquiling, *Reinking 2856*, on dead wood.

CLAVARIACEAE

PISTILLARIA Fries

PISTILLARIA sp.

Mount Maquiling, *Mendoza 3301*, on dead wood.

CLAVARIA Vaill

CLAVARIA sp.

Mount Maquiling, *Divinagracia 3394*, on dead wood.

PTERULA Fries

PTERULA ACICULAE Lloyd.

Mount Maquiling, *Baybay 3330*, on dead wood.

HYDNACEAE

PHLEBIA Fries

PHLEBIA REFLEXA Berk.

Parashorea plicata Brandis, Mount Maquiling, *Reinking 2979*, on bridge railing.

HYDNUM Linnaeus

HYDNUM OCHRACEUM Pers.

Mount Maquiling, *Reyes 3373*, on dead wood.

IRPEX Fries

IRPEX sp.

Mount Maquiling, *Nantes 3308*, on dead wood.

GRAMMOTHELE Berkeley et Curtis

GRAMMOTHELE MAPPA Berk. et Curt.

Mount Maquiling, *Cazeñas 991*, on dead wood.

POLYPORACEAE

PORIA Persoon

PORIA SETULOSA P. Henn.

Mount Maquiling, *Marquez 3358,* on dead wood.

PORIA sp.

Mallotus ricinoides Muell.-Arg., Mount Maquiling, *Reinking 2779,* on dead wood.

FOMES (Fries) Cooke

FOMES APPLANATUS Pers.

Ceiba pentandra (Linn.) Gaertn., Mount Maquiling, *Reyes 2943,* on dead wood.

FOMES AUSTRALIS Fr.

"Lawaṅ colorado," probably *Shorea* sp., Zamboanga, *Tecson 459,* on decaying branches.

FOMES CALIGNOSUS Berk.

Mount Maquiling, *Baybay 2590,* on dead wood.

FOMES PACHYPHLOEUS Pat.

Ficus sp., Mount Maquiling, *Collado 463,* on dead branch.

GANODERMA Karsten

GANODERMA AUSTRALE (Fr.) Pat.

Mount Maquiling, *Collado 473,* on dying tree.

POLYPORUS Micheli

POLYPORUS ADUSTUS Willd.

Terminalia comintana Merr., Mount Maquiling, *Reinking 2957,* on dead wood.

POLYPORUS AMBOINENSIS Fr.

Bambusa sp., Mount Maquiling, *Collado 2920,* on dead stem.

POLYPORUS ANEBUS Berk.

Bambusa spinosa Roxb., Mount Maquiling, *Reyes 2604,* on dead roots.

POLYPORUS CONCHOIDES Mont.

Parkia javanica (Lam.) Merr. (*Parkia timoriensis* Merr.), Mount Maquiling, *Reinking 2989,* on dead wood.

POLYPORUS DORSALIS Lloyd.

Mount Maquiling, *Nantes 655,* on dead wood.

POLYPORUS GRAMMOCEPHALUS Berk.

Mount Maquiling, *Marquez 3314*, on dead wood.

POLYPORUS LIGNOSUS Kl.

Ficus sp., Mount Maquiling, *Catalan 2919*, on dead branches.

POLYPORUS LUCIDUS Leys.

Bambusa sp., Mount Maquiling, *Collado 469*, *Baybay 2921*, on dead stump.

POLYPORUS MEGALOPORUS Mont.

Mount Maquiling, *Pañganiban 2571*, on dead wood.

POLYPORUS NITIDUS Murr.

Mount Maquiling, *Baybay 2591*, on dead wood.

POLYPORUS PERVERSUS Lloyd.

Mount Maquiling, *Pañganiban 3442*, on dead wood.

POLYPORUS RIGIDUS Lév.

Bambusa spinosa Roxb. (*Bambusa blumeana* Schultes), Mount Maquiling, *Reinking 3005*, on dead stumps.

Cyclostemon sp., Mount Maquiling, *Reinking 2959*, on dead wood.

POLYPORUS RUGULOSUS Lév.

Annona squamosa Linn., Mount Maquiling, *Reyes 2954*, on dead wood.

POLYPORUS SEMILACCATUS Berk.

Mount Maquiling, *Nantes 661*, on dead wood.

POLYPORUS SUBSTYGIUS Berk.

Gliricidia sepium (Jack.) Steud., Mount Maquiling, *Reinking 3006*, *Reyes 2942*, on weakened branches and on dead wood.

POLYPORUS VINOSUS Berk.

Mount Maquiling, *Mendoza 2559*, on dead wood.

POLYPORUS WILLIAMSIANUS Murr.

Arenga pinnata (Wurmb) Merr. (*Arenga saccharifera* Labill.), Mount Maquiling, *Reyes 2949*, on dead wood.

Cocos nucifera Linn., Mount Maquiling, *Reyes 2955*, on dead stump.

POLYPORUS ZONALIS Berk.

Cyclostemon sp., Mount Maquiling, *Reinking 2958*, on dead wood.

POLYPORUS sp.

Mount Maquiling, *Cazeñas 3421*, on dead wood.

POLYSTICTUS Fries

POLYSTICTUS AFFINIS Nees.

Mount Maquiling, *Marquez 2589, Cazeñas 3484, Ocfemia 3562,* on dead wood.

POLYSTICTUS CERVINO-GILVUS Jungh.

Mount Maquiling, *Baybay 979,* on dead wood.

POLYSTICTUS CRYPTOMENIAE P. Henn.

Theobroma cacao Linn., Mount Maquiling, *Baybay 751,* on dead branches.

POLYSTICTUS FLAVUS Jungh.

Elaeis guineensis Jacq., Mount Maquiling, *Reinking 2752,* on dead wood.

Ficus hauili Blanco, Mount Maquiling, *Reyes 2946,* on dead wood.

Leucaena glauca (Linn.) Benth., Mount Maquiling, *Reyes 2940,* on dead branches.

POLYSTICTUS LUTEUS Nees.

Mount Maquiling, *Marquez 3364,* on dead wood.

POLYSTICTUS MELEAGRIS Berk.

Los Baños Falls, *Ocfemia 3568,* on rotting log.

POLYSTICTUS MEYENII Kl.

Cordia myxa Linn., Mount Maquiling, *Reyes 2927,* on dead wood.

POLYSTICTUS MICROLOMA Lév.

Los Baños Falls, *Ocfemia 3567,* on decaying log.

POLYSTICTUS MURINUS Lév.

Los Baños Falls, *Ocfemia 3570, 3571,* on rotting log.

POLYSTICTUS OCCIDENTALIS Kl.

Canarium villosum (Blume) F.-Vill., Mount Maquiling, *Reinking 2871,* on dead wood.

POLYSTICTUS SANGUINEUS Linn.

Shorea sp., Mount Maquiling, *Reyes 2928,* on dead wood.

Shorea guiso Blume, Davao, Pantucan, *Reinking 2977,* on dead wood.

POLYSTICTUS SETULOSUS Lloyd.

Mount Maquiling, *Pañganiban 3397,* on dead wood.

POLYSTICTUS SUBCROCATUS Murr.

Mount Maquiling, *Collado 3481,* on dead wood.

POLYSTICTUS SUBREFLEXUS Lloyd.

Mount Maquiling, *Marquez 3382*, on dead wood.

POLYSTICTUS TABACINUS Mont.

Tabernaemontana pandacaqui Poir., Mount Maquiling, *Collado 2925*, on dead wood.

POLYSTICTUS XANTHOPUS Fr.

Quercus sp., Mount Maquiling, *Collado 2923*, on dead branches.

POLYSTICTUS ZELANICUS Berk.[1]

Shorea guiso Blume, Mount Maquiling, *Reyes 2951*, on dead stump.

POLYSTICTUS sp.

Mount Maquiling, *Divinagracia 1062*, *Cazeñas 804*, on decaying wood.

TRAMETES Fries

TRAMETES ACUTA Berk.

Mount Maquiling, *Cazeñas 3428*, on dead wood.

TRAMETES BADIA Berk.

Anisoptera sp., Mount Maquiling, *Reyes 2944*, on dead wood.

TRAMETES BURCHELLII Cooke.

Shorea guiso Blume, Mount Maquiling, *Reinking 2982*, on bridge flooring.

TRAMETES DEVEXA Berk.

Delonix regia (Boj.) Raf., Mount Maquiling, *Reinking 2924*, on weakened branches.

TRAMETES MEYENII Kl.

Annona reticulata Linn., Mount Maquiling, *Reyes 2926*, on dead wood.

TRAMETES PERSOONII Mont.

Erythrina indica Lam., Mount Maquiling, *Nantes 2497*, on dead wood.

Cordia myxa Linn., Mount Maquiling, *Reyes 2927*, on dead branches.

Ficus hauili Blanco, Mount Maquiling, *Reyes 2946*, on dead wood.

Ficus sp., Mount Maquiling, *Nantes 2530*, on dead wood.

Parkia javanica (Lam.) Merr. (*Parkia timoriensis* Merr.), Mount Maquiling, *Reinking 3007*, on dead wood.

[1] The determination was questionable, but since the fungus occurs on an important wood it seemed desirable to note it.

DAEDALEA Persoon

DAEDALEA FLAVIDA Lév.

Xanthostemon verdugonianus Naves, Mount Maquiling, *Luna 2352,* on dead wood.

Ficus sp., Mount Maquiling, *Collado 463, 466,* on dead wood.

DAEDALEA TENUIS Berk.

Ficus sp., Mount Maquiling, *Reyes 466,* on dead wood.

LENZITES Fries

LENZITES ALBIDA Berk.

Shorea guiso Blume, Mount Maquiling, *Reyes 2938,* on dead wood.

LENZITES REPANDA Pers.

Ficus sp., Mount Maquiling, *Collado 2346,* on dead wood.

LENZITES STRIATA Swartz.

Shorea guiso Blume, Mount Maquiling, *Reinking 2991, 3000,* on bridge flooring.

LENZITES TENUIS Lév.

Mount Maquiling, *Marquez 885,* on dead wood.

HEXAGONA Fries

HEXAGONA ALBIDA Berk.

Shorea guiso Blume, Mount Maquiling, *Reinking 3004,* on bridge flooring, *Reyes 2950,* on dead wood.

HEXAGONA FLAVIDA Lév.

Mount Maquiling, *Nantes 681,* on dead wood.

HEXAGONA TENUIS Hooker.

Mount Maquiling, *Collado 136,* on dead branch of a tree.

FAVOLUS Fries

FAVOLUS ALBUS Lloyd.

Mount Maquiling, *Marquez 1029,* on dead wood.

FAVOLUS PLATYPORUS Berk.

Mount Maquiling, *Cazeñas 3423,* on dead wood.

AGARICACEAE

CANTHARELLUS (Adans.) Linnaeus

CANTHARELLUS INFUNDIBULIFORMIS Berk.

Mount Maquiling, *Pañganiban 3452,* on dead wood.

SCHIZOPHYLLUM Fries

SCHIZOPHYLLUM COMMUNE Fr.

Ficus ulmifolia Lam., Mount Maquiling, *Reyes 2933,* on dead wood.

Mangifera indica Linn., Los Baños, college ground, *Reyes 2945, Reinking 3722,* on dead wood.

XEROTUS Fries

XEROTUS NIGRITUS Lév.

Shorea guiso Blume, Mount Maquiling, *Reinking 3003,* on bridge flooring.

Theobroma cacao Linn., Mount Maquiling, *Cazeñas 3322,* on dead wood.

LENTINUS Fries

LENTINUS CONNATUS Berk.

Mount Maquiling, *Collado 3485,* on dead wood.

LENTINUS SAJOR-CAJU Fr.

Mount Maquiling, *Marquez 997,* on dead wood.

LENTINUS SQUARROSULUS Mont.

Mangifera indica Linn., Jolo, *Reinking 2159,* on dead wood.

LENTINUS STRIGOSUS Schw.

Cocos nucifera Linn., Mount Maquiling, *Alas 2907,* on dead trunk.

MARASMIUS Fries

MARASMIUS EQUICRINIS Muell.

Mount Maquiling, *Marquez 3427,* on dead wood.

PLEUROTUS Fries

PLEUROTUS STRIATULUS Fr.

Urena lobata Linn., var. *sinuata* (Linn.) Gagnep., Mount Maquiling, *Reinking 2710,* on dead wood.

LYCOPERDACEAE

GEASTER (Micheli) Fries

GEASTER MIRABILIS Mont.

Mount Maquiling, *Cazeñas 3348, Marquez 3377,* on dead wood.

NIDULARIACEAE

CYATHUS Hallier

CYATHUS MONTAGNEI Tul.

Streblus asper Lour., Mount Maquiling, *Reinking 2770,* on dead wood.

CYATHUS PLICATUS Poeppig.

Mount Maquiling, *Pañganiban 3445*, on dead wood.

FUNGI LISTED ACCORDING TO HOSTS

ALANGIUM CHINENSE (Lour.) Rehd. (*Alangium begonifolium* Baill.)
Auricularia cornea Ehrenb., dead wood.
Corticium, dead wood.

ALSTONIA SCHOLARIS (Linn.) R. Br.
Auricularia auricula-judae (Linn.) Schr.

ANISOPTERA sp.
Trametes badia Berk., dead wood.

ANNONA RETICULATA Linn.
Trametes meyenii Klotz, dead wood.

ANNONA SQUAMOSA Linn.
Polyporus rugulosus Lev., dead wood.

ARENGA PINNATA (Wurmb) Merr. (*Arenga saccharifera* Labill.)
Cyphella fusco-disca Cke., dead petiole.
Polyporus williamsianus Murr., dead wood.

BAMBUSA sp.
Polyporus amboinensis Fries, dead stem.
Polyporus lucidus Leys., dead stump.
Thelephora radicans Berk., dead roots.

BAMBUSA SPINOSA Roxb. (*Bambusa blumeana* Schultes).
Polyporus anebus Berk., dead roots.
Polyporus rigidus Lev., dead stumps.

CAESALPINIA SAPPAN Linn.
Auricularia auricula-judae (Linn.) Schroet., dead wood.

CANARIUM VILLOSUM (Blume) F.-Vill.
Polystictus occidentalis Klotz, dead wood.

CAPPARIS sp.
Auricularia auricula-judae (Linn.) Schroet., dead wood.

CASUARINA EQUISETIFOLIA Forst.
Cyphella fusco-disca Cooke, dead wood.

CEIBA PENTANDRA (Linn.) Gaertn.
Fomes applanatus Pers., dead wood.

COCOS NUCIFERA Linn.
Lentinus strigosus Schw., dead stem.
Polyporus williamsianus Murr., dead stump.

CORDIA MYXA Linn.
Polystictus meyenii Klotz, dead wood.
Trametes persoonii Mont., dead branches.

CRESCENTIA CUJETE Linn.
Sebacina, dead wood.

CRYPTOCARYA sp.
Stereum ostreum Nees (or *Stereum lobatum* Swartz), decaying wood.

CYCLOSTEMON sp.
Polyporus rigidus Lév., dead wood.
Polyporus zonalis Berk., dead wood.

DELONIX REGIA (Boj.) Raf.
Trametes devexa Berk., weakened branches.

ELAEIS GUINEENSIS Jacq.
Asterostroma sp., dead wood.
Polystictus flavus Jungh., dead wood.

ERYTHRINA FUSCA Lour.
Cyphella mellea Burt., dead wood.

ERYTHRINA INDICA Linn.
Trametes persoonii Mont., dead wood.

EVODIA.
Auricularia auricula-judae (Linn.) Schroet., dead wood.
Hymenochaete sp., dead wood.

FICUS spp.
Daedalea flavida Lév., dead wood.
Daedalea tenuis Berk., dead wood.
Fomes pachyphloeus Pat., dead branch.
Lenzites repanda Pers., dead wood.
Polyporus lignosus Klotz, dead branches.
Trametes persoonii Mont., dead wood.

FICUS HAUILI Blanco.
Polystictus flavus Jungh., dead wood.
Trametes persoonii Mont., dead wood.

FICUS ULMIFOLIA Lam.
Schizophyllum commune Fr., dead wood.

GLIRICIDIA SEPIUM (Jacq.) Steud.
Polyporus substygius Berk., weakened branches and dead wood.
Stereum involutum Kl., dead wood.

LAGERSTROEMIA SPECIOSA Pers.
Corticium sp., dead wood.
Hymenochaete? dead wood.

LEUCAENA GLAUCA (Linn.) Benth.
Polystictus flavus Jungh., dead branches.

MACARANGA TANARIUS (Linn.) Muell.-Arg.
Tremella foliacea Fries, dead wood.

MALLOTUS MOLUCCANUS (Linn.) Muell.-Arg.
Auricularia cornea Ehrenb., dead wood.

MALLOTUS PHILIPPENSIS (Lam.) Muell.-Arg.
Peniophora sp., dead wood.

MALLOTUS RICINOIDES Muell.-Arg.
Poria sp., dead wood.

MANGIFERA INDICA Linn.
Lentinus squarrosulus Mont., dead wood.
Schizophyllum commune Fr., dead wood.

MELIA AZEDARACH Linn.
Auricularia auricula-judae (Linn.) Schroet., dead wood.

PARASHOREA.
Stereum sp., dead wood.

PARASHOREA PLICATA Brandis.
Guepinia spathulata Schw., bridge railing.
Phlebia reflexa Berk., bridge railing.

PARKIA JAVANICA (Lam.) Merr. (*Parkia timoriensis* Merr.)
Auricularia polytricha (Mont.) Sacc., dead wood.
Polyporus conchoides Mont., dead wood.
Trametes persoonii Mont., dead wood.

PSYCHOTRIA MANILLENSIS Bartl.
Corticium sp., dead wood.

PTEROCARPUS ECHINATUS Pers.
Auricularia auricula-judae (Linn.) Schroet., dead wood.

PTEROCARPUS INDICUS Willd.
Auricularia cornea Ehrenb., dead wood.

QUERCUS sp.
Polystictus xanthopus Fr., dead branches.

SHOREA sp.
Polystictus sanguineus Linn., dead wood.

SHOREA GUISO (Blanco) Blume.
Hexagona albida Berk., dead wood, bridge flooring.
Lenzites albida Berk., dead wood.
Lenzites striata Swartz, bridge flooring.
Polystictus sanguineus Linn., on logs.
Polystictus zelanicus Berk. ?, dead stump.
Stereum hirsutum Fr., bridge flooring.
Trametes burchellii Cke., bridge flooring.
Xerotus nigritus Lév., bridge flooring.

STREBLUS ASPER Lour.
Auricularia auricula-judae (Linn.) Schroet., dead wood.
Cyathus montagnei Tul., dead wood.

TABERNAEMONTANA PANDACAQUI Poir.
Polystictus tabacinus Mont., dead wood.

TECTONA GRANDIS Linn.
Corticium, dead wood.

TERMINALIA COMINTANA Merr.
Polyporus adustus Willd., dead wood.

THEOBROMA CACAO Linn.
Polystictus cryptomeniae P. Henn., dead branches.
Xerotus nigritus Lév., dead wood.

URENA LOBATA Linn. var. SINUATA (Linn.) Gagnep.
Pleurotus striatulus Fr., dead wood.

VITEX NEGUNDO Linn.
Auricularia cornea Ehrenb., dead wood.

XANTHOSTEMON VERDUGONIANUS Naves.
Daedalea flavida Lév., dead wood.

A BIOCHEMICAL STUDY OF COPRA MEAL [1]

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INTRODUCTION

In 1917 the Philippines produced about 186,900 tons of copra (21) which, after the oil was extracted, gave a by-product of 74,760 tons of copra meal. If all of this meal could be sold as feed, the additional return to the manufacturers would reach the respectable sum of 1,569,960 pesos.[2] Unfortunately, the nutritive value of the meal is not well known, and perhaps for this reason it is not used extensively as feed. Just now most of it is being used for fuel; but, when the price of coal becomes normal again, it could probably be used to greater advantage as feed. At present, the oil factories in the Islands are in a prosperous condition. This will naturally cause an increase in the demand for copra and in the amount of by-product obtained. It is, therefore, of the highest importance to know the real feeding value of this by-product.

A review of the literature on this subject will show that the biochemistry of copra meal has been studied to a limited extent only. The one work reported on the subject is that of the Hausmann number on the globulin of coconut determined by Osborne and Harris and included by Plimmer (18) in his table of nitrogen partition into three groups for different proteins.[3] Why this feeding stuff has been neglected by chemists is not known; it is probably due to the fact that only in recent years has the need

[1] Published with the permission of the Director of the Experiment Station of the College of Agriculture, University of the Philippines.

[2] Copra meal was sold (1918 and 1919) at 21 pesos a ton by the Philippine Oil Products Company, of San Pablo, Laguna. In May, 1919, the price of copra meal in Manila was 40 pesos a ton. At this rate 74,760 tons would cost 2,990,400 pesos.

[3] Since the manuscript for this paper was written C. O. Johns, A. J. Finks, and E. F. Gersdorff, Journ. Biol. Chem. 37 (1919) 149, have published data on the distribution of the basic nitrogen in coconut globulin. The average data of the analysis by the Van Slyke method given by these authors on page 152, have been included in Table 2.

for definite knowledge of the nature of the proteins in feeds been felt. Ten or fifteen years ago chemists were satisfied if they knew their crude-protein content, and they did not consider it important or necessary to get a more definite knowledge of its nature. The present work was intended as a preliminary study of this great problem and it was decided, first, to apply the Van Slyke method to the protein of copra meal taken as a whole and, second, to determine the proteins soluble in different solvents, both qualitatively and quantitatively.

Analyses of other feeding stuffs have been made by Grindley, Joseph and Slater(7) and by Grindley and Slater.(8)[4] Gortner,(4) who is emphatically against the idea of making a direct comparison between the analysis of protein unseparated from the feeding stuff and that of a pure protein, nevertheless admits that much comparative data can be obtained from the work of these authors. At present, the department of agricultural chemistry of the Philippine College of Agriculture is perfecting a plan for conducting a series of nutrition experiments with copra meal; and, because a more intimate knowledge of the protein of copra meal is necessary for this work, the carrying on of the experiments reported in this paper is believed to be justified. Individual proteins will be isolated and studied later.

DETERMINATION OF NITROGEN DISTRIBUTION IN COPRA MEAL

The copra meal, which was kindly furnished by Chesley, Conde and Company through Dr. Baldomero L. Roxas, of Manila, was ground fine, and on analysis showed the following composition:

TABLE 1.—*Composition of copra meal.*

	Per cent.
Moisture	11.3
Oil	12.2
Crude protein	20.1
Ash	5.5
Crude fiber	13.2
Carbohydrates	37.0

The ground meal was then dried under vacuum by Browne's method(3) and extracted with ether for eight hours. Two-gram samples were treated with hot water (at about 90° C.) for one

[4] Since the manuscript for this paper was prepared, H. C. Eckstein, and H. S. Grindley, Journ. Biol. Chem. 37 (1919) 373, have published a decidedly improved method "to determine directly the combined amino-acids of feedingstuffs by the application of the Van Slyke Method for the determination of the characteristic groups of amino-acids of proteins."

hour and then filtered. This treatment removed the water-soluble protein and a part of the salt-soluble, together with the starch and other soluble carbohydrates. The residue was washed thoroughly with hot water. The filtrate together with the washing was treated quantitatively for total nitrogen, and the residue hydrolyzed with 20 per cent hydrochloric acid (14) for forty-eight hours. The distribution of nitrogen in the hydrolysate was determined according to the directions in Plimmer's monograph (19) with certain modifications, stated below. The residue from hydrolysis was treated quantitatively for hydrochloric acid insoluble humin nitrogen in accordance with the method of Gortner and Holm. (6)

TABLE 2.—*Distribution of nitrogen in copra meal (two-gram samples).*

	Nitrogen in each sample.	Nitrogen average.	Different forms of hydrochloric-acid-soluble nitrogen.	Nitrogen in each sample.	Nitrogen average.	Total nitrogen insoluble in hot water.
	mg.	*mg.*		*mg.*	*mg.*	*Per cent.*
Nitrogen in hot water extract.[a]	14.1 12.6	13.35				
Hydrochloric acid-insoluble humin nitrogen.	1.41 1.27	1.34		1.41 1.27	1.34	2.24
			Humin nitrogen soluble in hydrochloric acid.	2.90	2.90	4.87
			Amide nitrogen	15.50 15.20	15.35	25.72
			Arginine nitrogen	7.00 7.00	7.00	11.73
Nitrogen soluble in hydrochloric acid.	61.14 55.52	58.33	Histidine nitrogen	2.35	2.35	3.94
			Lysine nitrogen	1.31	1.31	2.19
			Cystine nitrogen	4.05 3.82	3.93	6.58
			Mono-amino nitrogen	25.52 24.57	25.04	41.96
			Non-amino nitrogen	1.24	1.24	2.08
Total nitrogen		73.02			60.46	101.31

[a] The distribution of this nitrogen was not determined.

Hydrochloric acid insoluble humin nitrogen (mg.)	1.34
Hydrochloric acid soluble nitrogen (mg.)	58.33
Total nitrogen insoluble in hot water (mg.)	59.67
Nitrogen in hot water extract (mg.)	13.35
Total nitrogen by direct analysis (mg.)	73.02
Total nitrogen accounted for (per cent)	99.75

All of the total nitrogen determinations were made by the Kjeldahl-Gunning-Arnold method(22) using 1 gram of copper sulphate instead of mercury, and boiling for four hours(2) after the solution turned clear. The Claisen flasks of 1-liter capacity were found to be inadequate and 2-liter distilling flasks, modified for the purpose, were used instead. In the estimation of arginine Folin's improved absorption tubes(11) dipping into the standard acid were used instead of Folin bulbs, and 20 per cent sodium hydroxide(20) instead of 50 per cent. The absorption tubes were kindly loaned by the department of physiology of the College of Medicine and Surgery. The amino-nitrogen determinations were made at no fixed temperature, since the laboratory of agricultural chemistry of the College of Agriculture has no means for controlling this factor. Alizarine sodium monosulphonate was used as indicator in all of the titrations, and it was found more satisfactory than methyl orange. The results are recorded in Table 2, and are compared with the analyses of some known proteins in Table 3.

TABLE 3.—*Comparison of nitrogen distribution in the hot-water-insoluble portion of copra meal with that in some other products.*

Nitrogen.	Lactalbumin[a] plus equal weight of dextrose.[b]	Copra meal.	Cotton-seed meal.[c]	Coconut globulin.[d]	Coconut globulin.[e]
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Amide	8.37	25.72	10.45	7.36	7.99
Humin	3.70	7.11	7.78	0.76	[f]1.41
Cystine	1.05	6.58	0.65	----------	0.96
Arginine	8.10	11.73	19.52	32.79	29.50
Histidine	3.22	3.94	5.47	----------	3.68
Lysine	12.54	2.19	4.78	----------	6.41
Mono-amino	58.79	41.96	42.82	59.09	45.44
Non-amino	3.58	2.08	5.43	----------	4.60
Total	99.35	101.31	96.90	100.00	----------

[a] Gortner, R. A., Journ. Biol. Chem. **26** (1916) 182.

[b] The presence of tryptophane was tested in the water-soluble protein by the Hopkins-Cole and Benedict modified Hopkins-Cole reactions. (12)

[c] Grindley, H. S., Joseph, W. E., and Slater, W. E., Journ. Am. Chem. Soc. **37** (1915) 1779.

[d] Hawk, P. B., Practical Physiological Chemistry. Philadelphia, P. Blakiston's Son & Co. (1914) 400.

[e] See footnote 3.

[f] Humin absorbed by lime. 0.11 humin nitrogen in amyl alcohol extract.

Table 2 shows that the distribution of nitrogen in copra meal is fairly even. As stated above, the hot-water-soluble substances were eliminated before the copra meal was hydrolyzed with

hydrochloric acid, thus removing starch and other soluble carbohydrates, and the water- and part of the salt-soluble protein. The results are compared with the nitrogen distribution of lactalbumin plus an equal weight of dextrose as reported by Gortner.(5) When compared with this protein (Table 3) copra meal is found to be richer in amide, humin, cystine, arginine, and histidine, and poorer in lysine, mono-amino, and non-amino-acid nitrogen. Compared with cottonseed meal, it is found to be richer in amide and cystine nitrogen, and poorer in arginine, lysine, and non-amino-acid nitrogen. The humin and mono-amino-acid nitrogen of both are practically the same.

In short, copra meal, while rather poor in the sum total for lysine,(16) is rich in arginine, histidine,(1) and cystine.(17) The preliminary feeding experiments conducted by the animal husbandry department of the College of Agriculture seem to show that copra meal, when fed alone, cannot promote growth in hogs; but, when fed with green leaves, it furnishes a fairly perfect feed. It is possible that copra meal is lacking in "unknown accessories"(10) which here appear to be supplied by the green leaves.

The nitrogen partition in the hot-water-soluble proteins has not been studied. It is hoped that this will be done in the near future. Some idea of the distribution of nitrogen in these proteins may be gained by reference to the results with coconut globulin obtained by Osborne and Harris, and given in Plimmer's monograph.(18) These results calculated to percentage of total nitrogen have been included in Table 3.

DETERMINATION OF PROTEINS SOLUBLE IN DIFFERENT SOLVENTS

The fat-free copra meal, dried at room temperature, was treated according to the method proposed by H. H. Snyder and reported by Harcourt.(9) The meal was treated with water and then with salt solution before extracting it with alcohol. Chloroform was added to prevent decomposition. In the first trial only about 30 per cent of the protein was extracted by the different solvents. This was thought to be due to the inability of the solvents to penetrate the particles of the copra meal, the sample used being a mixture of meals that had been passed through 40-, 60-, 80-, and 100-mesh sieves, respectively. In the second trial only the sample passed through the 100-mesh sieve was used. It is regrettable that a finer sieve could not be obtained. The two samples gave the same amount of total nitrogen; so it trial only the sample passed through the 100-mesh sieve was was at first thought that they had the same composition. This

was proven not to be the case, as shown by the difference in their protein distribution. The results with the 100-mesh sample were still low. The method was then slightly modified, using the sample employed in the second trial. The mixture of sample and solvent was shaken repeatedly in a shaking machine, filtered and washed until the washing no longer gave a reaction for protein. Twelve hours were found to be sufficient to finish the extraction. This trial, although decidedly better than the first two, extracted only 47.55 per cent of the total protein. Since this laboratory has no facilities for very fine grinding, it was decided to discontinue the work for the present, and to report the results obtained.

A comparison of the results of trials 1 and 2 shows that the two samples, one composed of the materials passed through the 40- to 100-mesh sieves, and the other composed of the portion passed through the 100-mesh sieve, were not the same in general composition. The difference in protein distribution may be due to the fact that the sample used in trial 2 was composed of that portion of the copra meal which could be pulverized more easily; and it is not surprising to find, as in this case, that its composition was different from that of the portion harder to pulverize.

The results of trial 3 show that the modified method used is better for copra meal than the one proposed by H. H. Snyder. In this trial, the percentage of salt-soluble protein is lower than in trial 2. Most of the water-soluble protein is also salt-soluble; and, therefore, an increase in the water-soluble extract naturally causes a decrease in the salt-soluble fraction. When the percentages of the water- and the salt-soluble moieties are combined, the results in trial 3 show an improvement as compared with those in trial 2

Calculated in percentage of protein that went into solution, the mixed sample yielded more water- and salt-soluble than did the 100-mesh sample. The water- plus the salt-soluble in trial 3 is lower than in trial 2 by about 5 per cent in the alkali-soluble fraction of the former, which might explain the difference.

There is practically no alcohol-soluble protein. This partly agrees with the observation of Osborne(13) that alcohol-soluble protein is not found in any seed but cereals.

All the trials show that the alkali-soluble protein is the most abundant in copra meal.

Although this work is incomplete, it is believed that it may serve as a guide in the study of the biochemistry of copra meal.

TABLE 4.—*Distribution of proteins soluble in different solvents.*

TRIAL 1. MIXED SAMPLE.

Copra meal.	Nitrogen found in solvent.	Average nitrogen.	Nitrogen in meal taken.	Total nitrogen.	Solvent.	Protein dissolved.
gms.	*gms.*	*gms.*	*gms.*	*Per cent.*		*Per cent.*
10	0.03270					
10	0.03213	0.03268	0.33474	9.76	Water	33.54
10	0.03446					
10	0.03142					
10	0.02944					
10		0.02840	0.33474	8.48	10 per cent sodium chloride.	29.14
10	0.02916					
10	0.02661					
5	0.01847					
5	0.01769	0.01819	0.16737	10.86	0.2 per cent potassium hydroxide.	37.32
5	0.01840					
5						
5	trace					
5	trace	trace	0.16737	trace	70 per cent alcohol.	
5	trace					
5	trace					
Total				29.10		
Total nitrogen in residue (taken as check)				70.27		
Sum total				99.37		

TRIAL 2. 100-MESH SAMPLE.

10	0.02484					
10	0.02746	0.02613	0.33799	7.73	Water	20.76
10	0.02526					
10	0.02696					
10	0.01486					
10	0.01486	0.01604	0.33799	4.74	10 per cent sodium chloride.	12.73
10						
10	0.01839					
5	0.04260					
5	0.04271	0.04186	0.16900	24.77	0.2 per cent potassium hydroxide.	66.51
5						
5	0.04028					
5	trace					
5	trace		0.16900	trace	70 per cent alcohol.	
5	trace					
5	trace					
Total				37.24		

TABLE 4.—*Distribution of proteins soluble in different solvents*—Continued.

TRIAL 3. 100-MESH SAMPLE, MODIFIED METHOD.

Copra meal.	Nitrogen found in solvent.	Average nitrogen.	Nitrogen in meal taken.	Total nitrogen.	Solvent.	Protein dissolved.
gms.	*gms.*	*gms.*	*gms.*	*Per cent.*		*Per cent.*
10	0.03680	0.03620	0.33799	10.71	Water	22.53
10	0.03590					
10	0.03590					
10						
10	0.00835	0.00935	0.33799	2.77	10 per cent sodium chloride.	5.82
10	0.00948					
10	0.01023					
10						
5	0.05426	0.05758	0.16900	34.07	0.2 per cent potassium hydroxide.	71.65
5	0.05348					
5						
5	0.06500					
5	trace		0.16900	trace	70 per cent alcohol.	
5	trace					
5	trace					
5	trace					
Total				47.55		

The separation and purification of the alkali-soluble protein will be undertaken soon and a study made of its amino-acid content.

SUMMARY

1. The nitrogen partition in that portion of copra meal insoluble in hot water has been studied; it has been found that copra meal is rich in the amino-acids necessary for maintenance and growth.

2. It has been found that the alkali-soluble protein is the most abundant in copra meal.

3. The maximum amount of total protein nitrogen dissolved is only 47.55 per cent of the actual amount present in copra meal. This result seems to be rather low when compared with that obtained by Osborne and Campbell.(15) They were able to dissolve a total of 96.6 per cent of the protein nitrogen found in lupine seeds.

ACKNOWLEDGMENTS

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EIGHTH CONTRIBUTION TO THE COLEOPTERA FAUNA OF THE PHILIPPINES

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ONE COLORED PLATE AND ONE BLACK PLATE

In this paper I wish to make known among others a series of new and rather conspicuous Philippine Cerambycidæ. Our present knowledge of the identified longicorns of the Philippine Islands, aside from those herein described, comprises some two hundred eighty species of which about one-third was originally described by Newman [1] from material collected by Hugh Cuming during 1836 to 1840. Several other series of cerambycids, as well as other Coleoptera, of the Cuming material were described by Westwood, G. R. Waterhouse, Pascoe, and various other authors; and in no instance is the exact locality for the species given, except in some cases "Manilla," and for obvious reasons this locality name should be disregarded unless verified by new records. Concerning the localities of, as well as other data on, H. Cuming's collections from the Philippine Islands, useful references are given by Merrill.[2]

The following species are herein described:

CERAMBYCIDÆ

Megopis sanchezi sp. nov.
Nemophas rosenbergii ramosi subsp. nov.
Pachyteria ilocana sp. nov.
Aphrodisium luzonicum sp. nov.
Aphrodisium panayarum sp. nov.
Bicon luzonensis sp. nov.
Clytellus benguetanus sp. nov.
Neocollyrodes macgregori g. et sp. nov.
Pharsalia mindanaoensis sp. nov.
Euclea panayana sp. nov.
Euclea variolosa sp. nov.
Chlorisanis benguetanus sp. nov.

CURCULIONIDÆ

Pachyrrhynchus erosus sp. nov.
Calidiopsis affinis sp. nov.

DYNASTIDÆ

Xylotrupes mindanaoensis sp. nov.

[1] Newman, Edward, Cerambycitum Insularum Manillarum Dom. Cuming captarum enumeratio digesta, The Entomologist (1840–2) 243.

[2] Merrill, E. D., Genera and species erroneously credited to the Philippine flora, Philip. Journ. Sci. § C 10 (1915) 171; page 183 (an account of the localities of H. Cuming's collections in the Philippine Islands).

Megopis (Baralipton) sanchezi sp. nov. Plate 1, fig. 6, ♂.

Grayish brown, head, prothorax, and elytra covered with very fine pubescence. Head with a dimplelike depression on the front from which a well-pronounced medial line issues, reaching on to vertex. Antennary bases strongly produced. Antennæ of male slightly longer than body; of female one-fourth shorter than body. First joint twice as long as broad; first, third, and fourth joints closely granulated, finely and rather sparsely pubescent; last seven joints somewhat glossy. Third joint of male as long as fourth, fifth, and sixth joints together; third joint of female longer than fourth, fifth, and sixth joints together. Extreme apical part of each joint, except the last, blackish. Prothorax constricted anteriorly, gaining in width toward the base. Posterior-lateral angles produced, forming a flattened toothlike projection. Discal area with an irregular broad swelling toward the posterior margin. Elytra with inner and middle costæ strongly raised, castaneous brown, connected by a cross branch at the apical fourth. Outer costa faintly indicated in the basal half, but shortly before the middle it is more distinct, continued in two branches, the inner one of which runs into the medial costa, the outer one ending near the apex. A short spine at the apical termination of the suture. Abdominal segments and legs less densely pubescent. Last ventral segment of male strongly emarginate.

Male, length, 42.5 millimeters; width, 10.8. Female, length, 51.5 millimeters; width, 15.

LUZON, Benguet, Baguio (*W. Schultze*). Types in my collection.

This species is very destructive to the Benguet pine. On several visits to the pine-clad mountains of Benguet around Baguio and on the trail to Mount Santo Tomas I came across a number of old trees of *Pinus insularis* Endl., which were badly infested by a species of cerambycid. In 1917 I succeeded in rearing an adult of *Megopis sanchezi* from some larvæ that were kept in a piece of pine log.[3]

[3] In my Catalogue of the Coleoptera of the Philippine Islands, page 106, the above new species was erroneously identified as *Megopis cingalensis* White; therefore, the latter name should be eliminated from the Philippine list, and *M. sanchezi* is to be added.

Nemophas rosenbergii ramosi subsp. nov. Plate 2, fig. 2.

Head, prothorax underside, and legs densely covered by ocherous pubescence. Elytra dark metallic green, very coarse, confluent and somewhat granulate, deeply impressed punctures basally, which become less and less pronounced toward the apex. A narrow irregular pale ocherous band at the base, another creamy white, somewhat broader band before the middle, and a very broad band behind the middle. The anterior margin of the latter nearly straight, but the posterior margin forming an arch on each elytron. Still another band at the apex with a narrow bare spot.

Length, 34 millimeters; width at shoulder, 11; antenna, 54.

MINDANAO, Surigao, Surigao (*M. Ramos*). Type in my collection.

The close relationship of this species to *N. rosenbergii* Rits.[4] from Toelabollo, North Celebes, according to the description of the latter is apparent, but the markings seem to differ.

Pachyteria ilocana sp. nov. Plate 1, fig. 1, ♂.

Head punctulate and rugulose, black, except the front, which is rufescent-ochraceous. Interantennary ridge strongly concave and divided by a well-pronounced medial groove, the latter reaching from front to vertex. Palpi and antennæ rufescent-ochraceous and finely setose. Prothorax closely punctured, constricted and transversely grooved anteriorly and posteriorly. Lateral margins acute tuberculate. A distinct groove circumscribes a somewhat tumid area, which is finely coriaceous and of a rufescent-ochraceous color. This area extends dorsolaterally from the anterior transverse groove to the tubercle, thence to the posterior groove, and is continued ventrally, passing anterior to the intercoxal process of the prosternum. Discal area of prothorax more or less covered with short black velvety pubescence, except two small oblong glossy depressions, at the middle, near the anterior, and near the posterior transverse groove. Scutellum black. Elytra densely punctured, covered with velvety pubescence, black, except the basal area, which is rufescent-ochraceous. Each elytron showing slight traces of three longitudinal costæ. Body beneath glossy, dark violet blue and irregularly punctured. Along the posterior margin of the first abdominal segment an oblong patch of silvery gray pubescence. Legs rufescent-ochraceous, irregularly punctured, rugose and finely setose. A fringe of setæ on the

[4] Ritsema, Notes Leyd. Mus. (1881) 148; Heller, Tijdschr. voor Entom. 62 (1919) 102.

underside of the tibiæ, more strongly pronounced in the posterior tibiæ; claws black.

Length, 37 millimeters; width, 11.

LUZON, Ilocos Norte, Bangui. Type in my collection.

Aphrodisium panayarum sp. nov. Plate 1, fig. 8, ♀.

Female.—Head, prothorax, and scutellum metallic purplish bronze, very glossy; elytra and legs, except tarsi, dark blue. Head with front strongly concave, densely punctured, a medial groove which terminates between the eyes on vertex, the latter as well as sides of head densely rugulose-punctate. Antennæ dark blue, first joint densely punctulate, the following joints faintly black pubescent. Prothorax constricted and transversely grooved anteriorly and posteriorly, with a strongly pronounced tubercle at the middle of each lateral margin. Discal area densely and coarsely rugulose-punctate, very faintly pubescent, somewhat raised, forming a rather sharp ridge posteriorly. Anterior and posterior grooves in the middle smooth. Lateral margins rugulose-punctate. Scutellum with a shallow indistinct medial groove, punctured toward the margins. Elytra with basal area sparsely and scatteredly punctured, glossy and with a violet sheen; toward the middle densely punctured and black pubescent, and gradually less so toward the apex. Medial area with a faint greenish, the apical area with a steel-blue, sheen. Abdominal segments scatteredly and sparsely punctured, very glossy greenish blue. Femora irregularly finely and coarsely punctured and faintly pubescent, tibiæ densely punctured, especially posterior tibiæ densely blackish pubescent with a fringe of setæ. Tarsi rufescent ochraceous, claws black.

Female, length, 35 millimeters; width, 9.

PANAY, Antique, Culasi (*R. C. McGregor*). Type in my collection.

Aphrodisium luzonicum sp. nov. Plate 1, fig. 4, ♀.

Head, prothorax, and scutellum glossy metallic greenish bronze, elytra metallic blue with a green reflection. Head with front concave, irregularly coarsely punctured, a medial groove which terminates between the eyes on vertex. The latter irregularly punctate, sides of head rugulose-punctate. Prothorax similar in form to *A. panayarum,* the sculpture more pronounced. At the disk a well-pronounced bifid patch of black pubescence. Elytra, basally, sparsely and scatteredly punctured, toward the middle densely punctured and sparsely

black pubescent, less so toward the apex. Meso- and metathorax of female and in the male also the abdominal segments finely, somewhat iridescent, whitish pubescent. Abdominal segments of female glossy dark blue. Legs dark blue, except foretibiæ below, and tarsi, which are rufescent-ochraceous.

Male, length, 24.5 millimeters; width, 6.5. Female, length, 35 millimeters; width, 9.8.

LUZON, Ilocos Norte, Bangui (my collector). Types in my collection.

Aphrodisium semiignitum Chevr.[5] Plate 1, fig. 10, ♀.

As belonging to this species I identified several specimens that were caught with specimens of *Aphrodisium luzonicum* and *Pachyteria ilocana*, which are described in this paper. It is easily distinguished from *A. luzonicum* and *A. panayarum* by its strikingly different coloration: Head, prothorax, and elytra metallic reddish bronze, medial area toward lateral margins of elytra dark purple; antennæ and legs dark blue, except tarsi, which are rufescent-ochraceous. All the above-mentioned species were collected near Bangui, Ilocos Norte, Luzon, from certain flowers, on which they were feeding.

Bicon luzonensis sp. nov.

Head, antennæ, scutellum, elytra, and legs black; prothorax red. Head asperate, antennæ densely and irregularly punctured, third joint longest. Prothorax longer than broad, asperate, with a narrow blackish anterior marginal band. Elytra coarsely and densely punctured, especially toward the base, also somewhat granulated. Apex bispinose. Legs closely and strongly punctured and sparsely setose.

Male, length, 7.5 millimeters; width, 2. Female, length, 8.2 millimeters; width, 2.5.

LUZON, Bulacan, Angat (*M. Ramos*). Types in my collection.

Clytellus benguetanus sp. nov.

Black, very glossy. Head with front rugulose, with a well-pronounced medial carina and sparsely setose. Antennæ irregularly punctured, rugulose and sparsely setose, second joint half as long as third, third to sixth joints subequal in length, seventh to tenth joints shorter and broader than the former joints, eleventh joint longest. Prothorax impunctate, broadest anteriorly, strongly constricted at the posterior third, gaining

[5] Chevrolat, Rev. Zool. (1841) 227.

slightly in width again toward the posterior margin. Elytra strongly constricted before the middle, a few coarse punctures and a few white setæ at the constriction. At the apical triangle a small patch of silky white pubescence. Underside white pubescent. Legs sparsely whitish setose.

Length, 5.8 millimeters; width, 1.5.

LUZON, Benguet, Baguio (*W. Schultze*). Type in my collection.

Genus **NEOCOLLYRODES** novum

Head with the eyes very much produced; front concave, deeply notched between antennary bases, head slightly constricted behind the eyes. Antennæ filiform, reaching to basal fourth of elytra. First joint twice as long as broad; second joint one-third as long as first; third joint longest, twice as long as first and about equal in length to fourth and fifth together. Prothorax twice as long as broad, subcylindrical, slightly constricted posteriorly. Elytra subparallel in basal half, somewhat broader in apical half. Apex of each elytron with two acute angles. Legs slender, hind femora twice as long as front femora, the former reaching well beyond apex of elytra. Tibiæ with two spines at the apex. First tarsal joint of hind legs longer than the following joints together. This remarkable genus, resembling in aspect, and having a mimicry relationship to, the genus *Collyris* of the Cicindelidæ, I propose to place near *Collyrodes* Pascoe.[6]

Type, *Neocollyrodes macgregori* sp. nov.

Neocollyrodes macgregori sp. nov. Plate 1, fig. 5.

Glossy bluish black, femora dark red. Front with a strongly raised glossy medial ridge forming a triangle, laterally irregularly punctured; sides of head irregularly punctured, behind the eyes rugose. A bluish white tomentose spot on vertex. Antennæ with first and second joints glossy, third to fifth joints dorsally bluish white tomentose. Prothorax with an anterior and posterior submarginal groove, the surface strongly asperate and rugose, toward the base an irregular oblong smooth area. Apical third in female with a large black pubescent patch. At the middle laterally a small round bluish white tomentose spot and another at the base. Scutellum white tomentose. Elytra with a small round bluish white tomentose spot at the

[6] Pascoe, Trans. Ent. Soc. London II 5 (1859) 25.

basal fourth, a fascia interrupted at the suture and not reaching lateral margins, being located behind the middle. Two other roundish tomentose spots on each elytron in apical area. Basal area, up to the fascia, glossy, coarsely and confluently punctured and rugose toward the lateral margins, the sculpture similar to that found in species of the genus *Collyris*. Apical half finely and densely punctured and beset with black pubescence, which disappears toward apex. Underside irregularly punctured and finely setose. Episterna of metathorax with a white tomentose patch. First abdominal segment with a bluish white spot toward each lateral margin. Legs sparsely punctured and finely setose. Apical part, dorsally, of femora, tibiæ, and tarsi entirely, bluish white tomentose.

Male, length, 21 millimeters; width, 3. Female, length, 22 millimeters; width, 3.3.

PANAY, Antique, Culasi (*R. C. McGregor*). Type in my collection.

Three other specimens from Luzon, Paete, Laguna Province, and Bosoboso, Rizal Province, differ from the typical specimens of Panay in the following respect: The punctation on the basal half of the elytra is distinctly less pronounced and is sparser and less confluent.

Pharsalia mindanaoensis sp. nov. Plate 1, fig. 7.

Black, prothorax reddish brown, elytra with numerous pale reddish and very irregular narrow bands or spots. Head black, finely and sparsely silvery gray pubescent, front finely and densely punctured with a few scattered coarse punctures. A fine medial groove reaching to vertex. Antennæ black, finely pubescent, last five joints entirely white. Prothorax much broader than long, densely reddish brown pubescent. The spine at the lateral margins is located slightly behind the middle. An anterior and posterior submarginal groove. Discal area with some coarse scattered punctures, an indistinct ridge in the posterior half. Elytra black with numerous irregular combinations of pale reddish bands, which are more condensed toward the apex. Black areas with scattered coarse punctures. Underside pale reddish brown, middle of abdominal segments blackish. Last abdominal segment strongly emarginate. Legs black, finely and sparsely silvery gray pubescent.

Length, 25 millimeters; width, 7.5.

MINDANAO, Surigao, Surigao. Type in my collection.

Euclea panayana sp. nov. Plate 1, fig. 3.

Black. Head irregularly punctured. Front with a medial carina and two narrow tomentose stripes, forming the letter V; terminating on vertex. Prothorax irregularly punctured except a narrow oblong area discally impunctate. An oblique stripe extending from anterior margin, somewhat lateral, to lateral-posterior margin, gaining in width toward the latter margin. Elytra coarsely and densely punctured, less so in the apical half discally. A broad fascia of pale pinkish white extending from the suture posteriorly of scutellum obliquely to lateral margins, and beyond the middle from the margins oblique-posteriorly to the suture. Inside the fascia, at the suture and toward the base a small subtriangular bare spot. Apical third with a small triangular tomentose spot at lateral margin and another larger oblong subsutural spot at apical triangle. These spots as well as stripes on head and prothorax dark cream color, also pro-, meso-, and metasternum. Abdominal segments and femora finely whitish pubescent, in the former more pronounced along the posterior margins. Tibiæ and tarsi black pubescent.

Length, 17.5 millimeters; width, 5.5.

PANAY, Capiz Province, mountains near Jamindan. Type in my collection.

This species is nearly related to *E. mesoleuca* Pascoe.[7] Manila, the locality given for this species by Pascoe, seems very doubtful, since specimens which I identified by comparison with the type in the British Museum as *E. mesoleuca* Pasc. were collected by R. C. McGregor in Sibuyan Island. In Pascoe's species the bare spot at the suture of the elytra is located in the middle of the fascia and is large and roundish as compared to the very small bare sutural spot of *E. panayana* Schultze which is located close to the scutellum.

Euclea variolosa sp. nov. Plate 1, fig. 9.

Glossy black; head sparsely, irregularly, coarsely punctured. A well-pronounced medial carina from front to vertex. Front rufescent tomentose, at vertex this color intermixed with white. Small irregularly scattered bare spots are generally located around the punctures. Prothorax one-fifth broader than long, a small tubercle at lateral margins, irregularly scatteredly punc-

[7] Pascoe, Trans. Ent. Soc. London III 3 (1865) 150.
"*Euclea mesoleuca.*
"E. nigra, nitida, pube sparse niveo-irrorata; elytris punctatis, fascia latissima dense niveo-pubescente, adsuturam interrupta, ornatis.
"Hab.—Manila."

tured, rufescent and whitish tomentose with irregularly scattered bare spots. Elytra irregularly punctured, confluent pale rufescent and white tomentose.

Length, 27.5 millimeters; width, 8.7.

PANAY, Antique, Culasi (*R. C. McGregor*). Type in my collection.

This species is easily distinguished by its much stouter form and larger size from the other Philippine representatives of this genus.

Chlorisanis benguetanus sp. nov. Plate 1, fig. 2.

Dark metallic blue. Head sparsely and scatteredly punctured. Antennæ dark blue. Prothorax irregularly and scatteredly punctured. Discal area with two small roundish and an oblong callosity, the latter in the basal half. Elytra very densely and coarsely punctured, the punctures growing less toward apex. Lateral margins abruptly set off by a carina. Subsutural and apical areas finely pubescent, apical end of each elytron with two obtuse spines. Margins of apical fourth beset with rather long black setæ. Underside glossy green, finely whitish pubescent. Femora rufescent-ochraceous, glossy; tibiæ and tarsi black, pubescent, and setose, more pronounced on the posterior legs.

Length, 17 millimeters; width, 4.5.

LUZON, Benguet, Baguio (*F. Sanchez, S. J.*) Type in my collection.

From *C. viridis* Pascoe,[8] the type of the genus from Sarawak, the above species is easily distinguished by the rufescent-ochraceous femora.

Pachyrrhynchus erosus sp. nov.

Black, glossy; elytra with a series of fine longitudinal grooves, which form loops as in *Macrocyrtus erosus* Pasc. Head with rostrum in the basal half strongly depressed with a scale spot which is divided by a longitudinal groove extending to the front. Prothorax subglobular with a strongly pronounced anterior and a posterior submarginal groove. Elytra with nine or ten longitudinal grooves, respectively, one at the suture being common to both elytra, closely beset with creamy white scales, the grooves forming five loops. The shortest loop is located subsuturally, the others extend from near the base to the apical fourth. Near the apex and subsuturally another short oblong loop and at the apical triangle a triangular loop. Legs with a scale spot at the femora apically.

[8] Pascoe, Trans. Ent. Soc. London III 3 (1867) 413, pl. 16, fig. 7.

Male, length, 12 millimeters; width, 5. Female, length, 14 millimeters; width, 6.6.

LUZON, Benguet, mountain trail near Atoc (*W. Schultze*). Types in my collection.

The species is closely related to *P. annulatus* Chevr., *anellifer* Heller, and *schuetzei* Schultze. On a recent collecting trip to the Benguet mountains, during October to December, 1919, I was fortunate in finding a good series of this species, which varies very little, and in obtaining some data on its peculiar habits. This species was found near the trail at the steep mountain sides on tall, coarse grass growing between the rocks. All specimens were collected from about 4 o'clock in the afternoon until dark, in the act of crawling up. Several specimens found had recently emerged and were quite soft. A number were found in copula. Together with this species and from the same grass I collected a hitherto unidentified *Metapocyrtus* sp. in appearance very much resembling the former.

Pachyrrhynchus pinorum Pasc.

In a former paper [9] I omitted to mention from Baguio, Benguet, the species *P. chevrolati* Eyd. et Soul. and the commonest, *P. pinorum* Pasc. Many specimens of the last-mentioned species were collected at and around Baguio. These specimens have the broad grooves beset with very indistinct and little-pronounced rudimentary scales. On my recent trip I collected near Atoc, Benguet, a number of specimens of *P. pinorum* which have the grooves closely beset with small white scales. In structure, these specimens do not vary from those from Baguio.

Calidiopsis affinis sp. nov.

Closely related to *C. lineata* Schultze. Black, with longitudinal white stripes on the elytra. Antenna with the scape with scattered whitish scales and densely beset with fine black bristles, funicular joints whitish, the second joint being the longest. Prothorax very coarsely and irregularly punctured. A white medial line and another ill-defined line and a patch of scales at each lateral margin. Elytra with much coarser sculpture than in *C. lineata*, beset with black bristles which are slightly longer than in the above species. A white sutural stripe from the base to the apex, and three stripes on each elytron, and another stripe at the lateral margin surrounded by scattered scales. Underside and legs closely covered with greenish white scales.

[9] Philip. Journ. Sci. § D 12 (1917) 252.

Length, 10 millimeters; width, 4.2.

MINDANAO, Zamboanga, Malangas (my collector). Type in my collection.

DYNASTIDÆ

Xylotrupes mindanaoensis sp. nov. Plate 2, fig. 1, *a, b, c.*

Black, pronotum and elytra pale grayish brown, velvety iridescent pubescent, less pronounced in the female. Male: Head with a suberect, slightly curved horn, which is laterally slightly compressed and terminates in two diverging branches. Lateral basal angles of the horn forming a strongly pronounced toothlike projection. Pronotum, the anterior lateral angles very strongly projecting, at the disk a short, stout horn directed forward and bifid at the extremity. The pronotum irregularly and confluently punctured and densely beset with a short velvety pubescence, except the horn, which is bare toward the extremity above. Scutellum coarsely, irregularly punctured, with a posterior submarginal groove. Elytra irregularly punctured and very densely beset with velvety iridescent pubescence. Pygidium also densely pubescent. Metathorax beset with reddish hair. Abdominal segments irregularly punctured. Female: Head at the vertex with a very small obtuse tuberculate projection. Pronotum very coarsely and confluently punctured, toward the margins coriaceous, and sparsely pubescent. Elytra also velvety iridescent pubescent, but less pronounced than in the male.

Male, length, 34 millimeters; width at shoulder, 17.5. Female, length, 34 millimeters; width at shoulder, 16.5.

MINDANAO, Surigao, Surigao (*J. Ramos*), found in copula. Types in my collection.

This species is readily distinguished by the peculiar scalelike velvety iridescent pubescence, somewhat similar to that of species of cerambycids belonging to the genus *Aeolesthes.*

NOTES ON SOME PHILIPPINE DYNASTIDÆ

In my Catalogue of Philippine Coleoptera, page 173, I included *Dipelicus deiphobus* Sharp (det. C. Felsche). This species should be eliminated from the Philippine list since the species in question is *Dipelicus robustus* Heller.[10]

Furthermore, *Xylotrupes pubescens* Waterh.[11] is a valid species and not a synonym of *X. phorbanta* Oliv. The last mentioned is considered by Arrow [12] as a synonym of *X. gideon* Linn.

[10] Heller, Notes Leyden Mus., 19 (1897) 172.

[11] Waterhouse, Proc. Ent. Soc. London (1841) 17; Ann. & Mag. Nat. Hist. 7 (1841) 539.

[12] Arrow, Fauna Brit. India, Col. (1910) 262.

ILLUSTRATIONS

PLATE 1

[Original drawings by W. Schultze.]

FIG. 1. *Pachyteria ilocana* sp. nov., male.
2. *Chlorisanis benguetanus* sp. nov.
3. *Euclea panayana* sp. nov.
4. *Aphrodisium luzonicum* sp. nov., female.
5. *Neocollyrodes macgregori* g. et sp. nov.
6. *Megopis* (*Baralipton*) *sanchezi* sp. nov., male.
7. *Pharsalia mindanaoensis* sp. nov.
8. *Aphrodisium panayarum* sp. nov., female.
9. *Euclea variolosa* sp. nov.
10. *Aphrodisium semiignitum* Chevr., female.

PLATE 2

FIG. 1. *Xylotrupes mindanaoensis* sp. nov., *a*, male, dorsal view; *b*, male, dorsolateral view; *c*, female, dorsal view.
2. *Nemophas rosenbergii ramosi* subsp. nov.

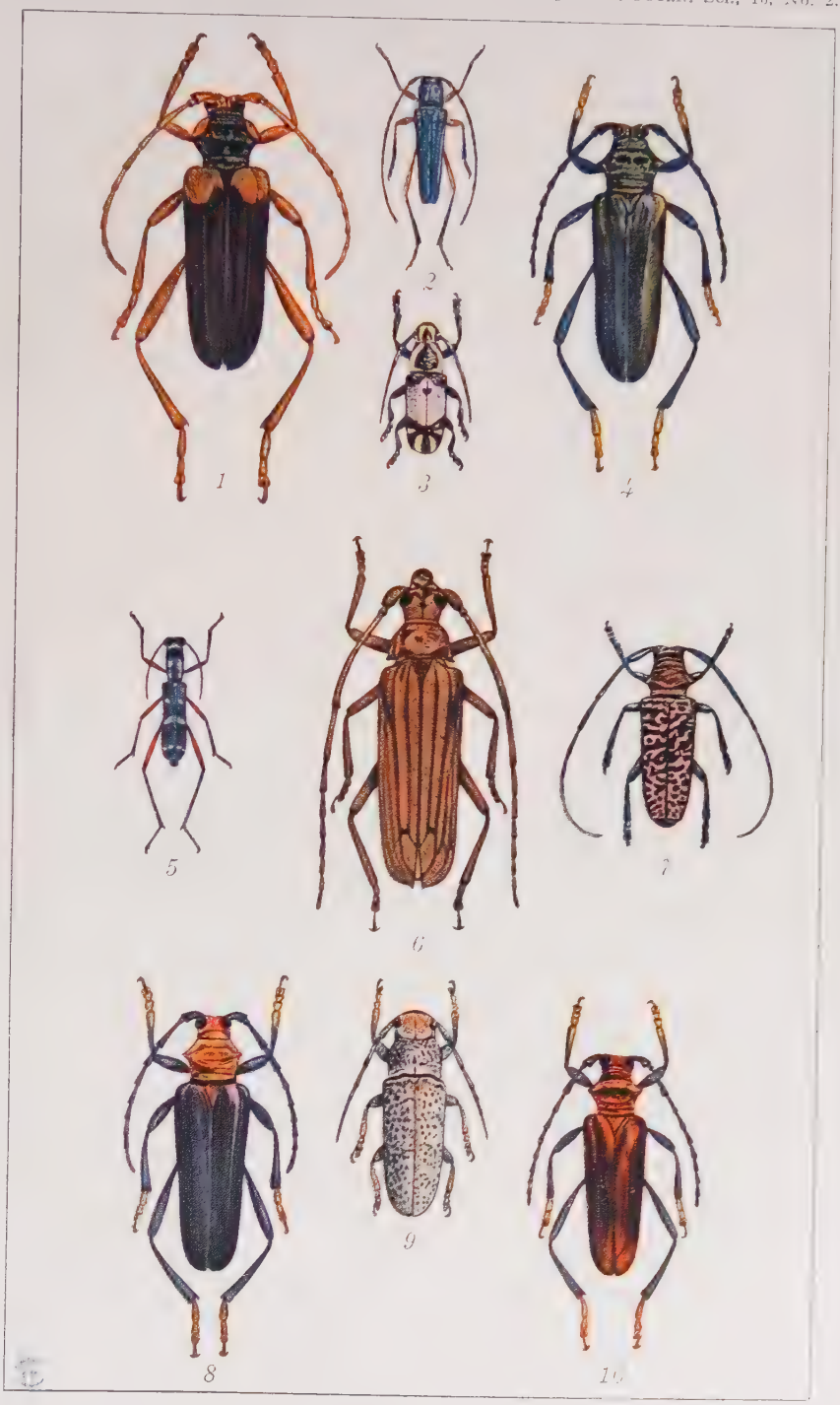

PLATE 1. PHILIPPINE COLEOPTERA

Fig. 1. Xylotrupes mindanaoensis sp. nov.

Fig. 2. Nemophas rosenbergii ramosi subsp. nov.

PLATE 2. PHILIPPINE COLEOPTERA.

SUPPLEMENTARY NOTES ON PHILIPPINE BEES

By T. D. A. Cockerell

Of the University of Colorado

Xylocopa fallax mcgregori subsp. nov.

Abdomen in both sexes black, wholly without any green tint, and the first two segments without any distinct hair bands; antennæ black, reddened only at end of last joint; anterior wings of male, 22 millimeters long, rarely 23 (26 in typical *fallax*); of female, 21 to 24.5.

Luzon, Manila, July 24 and 25, 1919, type, at flowers of *Peltophorum inerme* (Roxb.) Naves, 22 females and 6 males; Manila, July 26, 1 male at *Antigonon leptopus* Hook. and Arn.: Bulacan Province, Obando, October, 1919, 1 female. All collected by R. C. McGregor. Two males, previously recorded as *X. fallax*, obtained by Baker at Baguio, differ from the above by the distinctly paler wings; the anterior wings measure 21.5 millimeters in one, 24.5 in the other. The Baguio form, when better known, may prove to be a separable race.

Xylocopa fallax was described by Maidl from two females and a male collected by "V. Schadberg" [doubtless von Schadenberg] in the Philippines, the particular island not stated. With the long series of fresh specimens before me, it is evident that the Manila form is not typical, though there appears to be no reason for regarding it as a distinct species. Presumably typical *fallax* is from some other island, and at present unknown to me.

The resemblance of *X. fallax mcgregori* to *X. pictipennis* Smith, from Java, is so close that I was inclined to consider it identical, until I noticed that *pictipennis* has the third antennal joint conspicuously longer, and the punctures on the clypeus larger and not so dense. I have a *pictipennis* from F. Smith's collection. *Xylocopa pictipennis* is larger than *mcgregori*.

Xylocopa nigrocærulea Smith.

Prof. C. F. Baker calls my attention to the fact that Gribodo records this from Mindoro, Palawan, and Mindanao. I have not seen it from the Philippine Islands; the wings are brown, not dark, with coppery iridescence; pubescence black; abdomen blue-black. It was described from Celebes, but according to

Bingham it also occurs in Ceylon. Bingham describes the abdomen as "deep obscure bottle-green."

Mesotrichia bombiformis (Smith).

Evidently common at Manila, where Mr. McGregor took it, July 23 to 26, at flowers of *Peltophorum inerme* and *Antigonon leptopus*. Also one from Obando, Bulacan Province, Luzon, October, 1919 (*McGregor*).

Mesotrichia philippinensis chlorina Cockerell.

LUZON, Manila, 9 females, collected as follows: March 2, 1919, at flowers of *Gliricidia sepium* (Jacq.) Steud.; June, and July 23, at flowers of *Peltophorum inerme;* July 26, at flowers of *Antigonon leptopus;* and September 21. All collected by McGregor. One specimen, taken in September, has the green wings of *chlorina,* but the yellow band on thorax posteriorly is narrowed to a line in the middle, so that the insect approaches true *philippinensis.* Another, taken July 23, has the wings mainly purplish, approaching *philippinensis* in this respect; but the thoracic band is as in *chlorina.* Two have a distinct patch of yellow hair beneath the wings, but this is usually wanting or reduced to a few inconspicuous hairs. In the type of *chlorina* it is present but small. The absence of this patch is a character of the form *bilineata* (Friese), but none of our bees is small enough for that.

With the females comes a male; Manila, July 26, at *Antigonon leptopus.* It is the insect which I provisionally regarded as the male of *M. bakeriana* Cockerell, but it now seems likely that it belongs to *chlorina.*

Megachile valdezi (Cockerell).

LUZON, Manila, February 12, 1919 (*McGregor*), 1 female.

Megachile mcgregori Cockerell.

LUZON, Bulacan Province, Obando, October, 1919 (*McGregor*), 1 male. In my table of Philippine *Megachile* this species is placed among those in which the tarsi have no long fringe behind. This is erroneous; all the tarsi have long creamy-white fringes, those of the hind tarsi in front. From *M. laticeps* Smith it is easily known by the white hair bands, broadly interrupted or reduced to a few hairs in middle, on abdominal segments 2 to 4.

Anthophora korotonensis var. **stantoni** (Cockerell).

LUZON, Manila, February 11, 12, and 14, 1919, 1 female and 8 males; October 9, 1918, a male at flowers of *Stachytarpheta*

jamaicensis (Linn.) Vahl; November 25, 1918, 1 female. All collected by McGregor. The males vary, having the first, or first and second, band green; the rest blue.

Ceratina sexmaculata Smith.

LUZON, Manila, June, 1919 (*McGregor*), 1 male.

Ceratina dentipes Friese.

LUZON, Manila, June, 1919 (*McGregor*), 1 female. I have no specimens from Java, whence the species was described; but Friese determined the Philippine insect as *dentipes* for Baker years ago.

Ceratina philippinensis Ashmead.

LUZON, Manila, June, 1919 (*McGregor*), 2 females.

Ceratina bicuneata Cockerell.

This was described from females, but I find I have a male from Baguio, Benguet (*Baker*). It is about 6.5 millimeters long, similar in most respects to the female. The face has remarkably large and coarse punctures; lateral face marks entire, ending obliquely above and below, the shape not unlike that of the hull of a sailing ship; clypeal mark confined to lower half of clypeus, large and trilobate, not reaching lateral marks; supraclypeal mark transverse, bow-shaped. The middle and hind tibiæ are yellow, with a dark spot behind, the hind tibiæ also with a reddish spot in front near end. The labrum is entirely black. The apex of the abdomen has a well-defined median point.

Heriades sauteri philippinensis (Friese).

This was described from the female. Two males from Mount Maquiling, Luzon (*Baker*), are extremely like *H. sauteri* from Formosa, but the abdomen is more finely and densely punctured and therefore less shining.

Heriades mundulus sp. nov.

Male.—Length, about 4.5 millimeters; similar to *H. sauteri philippinensis,* but mesothorax much more finely punctured (about three punctures in 95 microns), while the ventral surface of the abdomen is clear ferruginous. The hair at the sides of the upper part of the face is pale reddish. Wings dusky hyaline, grayish.

PALAWAN, Puerto Princesa (*Baker*), 1 male. The mesothorax is much more finely punctured than in *H. fulvescens* Ckll., from Borneo.

REVIEWS

The Wassermann Test | by | Charles F. Craig, A. M. (Hon.), M. D. (Yale) | [six lines of titles] | Published with authority of the Surgeon General, | United States Army | illustrated with colored plates, half-tone | plates, and fifty-seven tables | St. Louis | C. V. Mosby Company | 1918 | Cloth, pp. 1–239, including index.

FROM THE PREFACE

The work has been largely prepared since the outbreak of the present war and, for this reason, is not as exhaustive as I had originally intended it to be, as owing to official duties it has been impossible to spend as much time in its preparation as would have been necessary to make it an exhaustive treatise, and it has also been impossible for me to consult much of the very extensive literature that has accumulated during recent years in regard to the test. However, it is believed that the work contains all of the essential and really valuable facts regarding the test which have been reported in the literature, and if there have been any omissions I would deem it a favor to have them called to my attention.

I have quoted quite liberally from some of the more recent investigators, as Noguchi, Nichols, Vedder, and Kolmer, and have also used much data previously published by myself in various medical journals, and it is a pleasure to tender my thanks to the editors of the *Journal of the American Medical Association,* the *Journal of Experimental Medicine,* the *Journal of Infectious Diseases,* and the *American Journal of Syphilis,* for permission to avail myself of the data previously published in these journals.

From personal experience, I believe that there is still a great deal of misunderstanding and confusion among the members of the medical profession regarding the exact value and limitations of the Wassermann test, both in the diagnosis of syphilis, and when used as a control of the treatment of the disease, and if this work will help in clearing up this confusion it will be a source of great gratification. Much of this misunderstanding rests upon the shoulders of laboratory workers, for it must be admitted that too often the performance of the Wassermann test has been delegated to poorly trained or careless assistants, and the results obtained with the test have thus been erroneous and unsatisfactory. I can not urge too strongly upon the profes-

sion the necessity for submitting material for this test to well-qualified serologists if reliable results are to be obtained. A standard technic for the test is much to be desired but all efforts in this direction have failed, owing largely to the difficulty of securing a standard antigen, so that at the present time several methods of performing the test are in use, all of which are reliable in the hands of experienced serologists. The method recommended in this work has stood the test of time and has been used by many different workers in thousands of syphilitic infections, and it is believed that it is as simple in technic and as accurate in results as any method of performing the Wassermann test that has been devised.

The | Medical Clinics | of | North America | July, 1919 | published bi-monthly by | W. B. Saunders Company | Philadelphia and London | Paper, pp. 1–277.

The Chicago Number, Volume III, No. 1, contains the following papers:

Prognosis of Disease in Infancy and Childhood, by Dr. Isaac A. Abt.

A case of Hanot's Cirrhosis in a Two-year-old Child, by Dr. Isaac A. Abt.

A Mediastinal tumor, by Dr. Frederick Tice.

Carcinoma of the stomach, by Dr. Frederick Tice.

Radiographic differential diagnosis of bone affections in infancy and childhood, by Dr. Julius H. Hess.

An unusual case of carcinomatous metastases in bones secondary to carcinoma of the stomach, by Dr. Milton M. Portis.

Acute pyelitis simulating intestinal obstruction, by Dr. Milton M. Portis.

Carcinoma of the esophagus treated with radium, by Dr. Milton M. Portis.

A case of cerebral lues to be differentiated from encephalitis lethargica, by Dr. Ralph C. Hamill.

Neurologic findings in a case of ethmoiditis, by Dr. Ralph C. Hamill.

A consideration of the causes of apprehension, by Dr. Ralph C. Hamill.

Pyelocystitis in infancy, by Dr. Clifford G. Grulee.

Pulmonary tuberculosis in association with other diseases in the general hospital.

Case I. Pulmonary tuberculosis with gastro-intestinal symptoms.

Case II. Pulmonary tuberculosis and hyperthyroidism.

Case III. Diabetes and tuberculosis, by Dr. Solomon Strouse.

A case of belladonna poisoning, by Dr. Solomon Strouse.

Malignant endocarditis of the pulmonary valves (with autopsy), by Dr. Charles Spencer Williamson.

Gout, by Dr. Charles Spencer Williamson.

The Swift-Ellis treatment of paretic dementia, by Dr. Peter Bassoe.

The treatment of constipation, by Dr. W. D. Sansum.

An unusual case of typhoid fever, by Dr. George F. Dick.

Cardiac arhythmias, by Dr. James G. Carr.

A case of syphilitic periostitis of the humerus, by Dr. James G. Carr.

A pulmonary abscess following tonsillectomy, by Dr. James G. Carr.

Some aspects of Hodgkin's disease, by Dr. Arthur F. Byfield.

Eye findings as an aid to the diagnosis of general conditions; a suggestion for team-work, by Dr. Richard J. Tivnen.

Some interesting ear cases, by Dr. Robert Sonnenschein.

Irregular placement and fixation of the large bowel, by Dr. Walter W. Hamburger.

A consideration of the abnormal loss of fluid in contrast with Edema, by Dr. Frank Wright.

The Health | of the Teacher | by | William Estabrook Chancellor | Author of "Our Schools," etc. | Chicago | Forbes & Company | 1919. Cloth, pp. i–ix + 1–307, including index, $1.25.

FROM THE PREFACE

The purpose of this book is to guide teachers in the care of their own health while teaching. The need for it arises from several sources. First, the occupation has very high rates both of deaths and of diseases. Second, teachers read too many school physiologies, which have in view the public needs of children and youth and which do not teach the whole truth for adults. Third, such books as have appeared for adult teachers have not been written by men with medical training and experience but by teachers of hygiene who have considered the subject pedagogically rather than medically. Fourth, every book so far issued associates public sanitation with personal hygiene, thereby adding to the sense of responsibility felt by the already burdened teacher. The present discussion is meant to be essentially different in its motives and purposes.

The inner purpose of the book is to help teachers maintain health despite the necessity to accomodate themselves often to seriously unhealthy surroundings and regimen. It is, however, well for us all to remember that there are other occupations with yet greater difficulties to be met and overcome such as medicine, nursing, home management on a farm and some lines of factory, store and office employment. Let us, therefore, try to endure with healthy cheerfulness what for the present perhaps we cannot change.

And let us not imagine that from the point of view of hygiene or of any other art or science, even the best of modern schoolhouses or the latest of modern school courses and programs is a finality. Mankind is at the beginning, not the end of the discovery of truth. But even such truth as we now have is but narrowly distributed and but poorly utilized. In these pages, I have endeavored to present in untechnical, non-medical language as far as possible some of the most approved principles and practices of physicians and of hygienists for the maintenance and protection of the personal health of teachers.